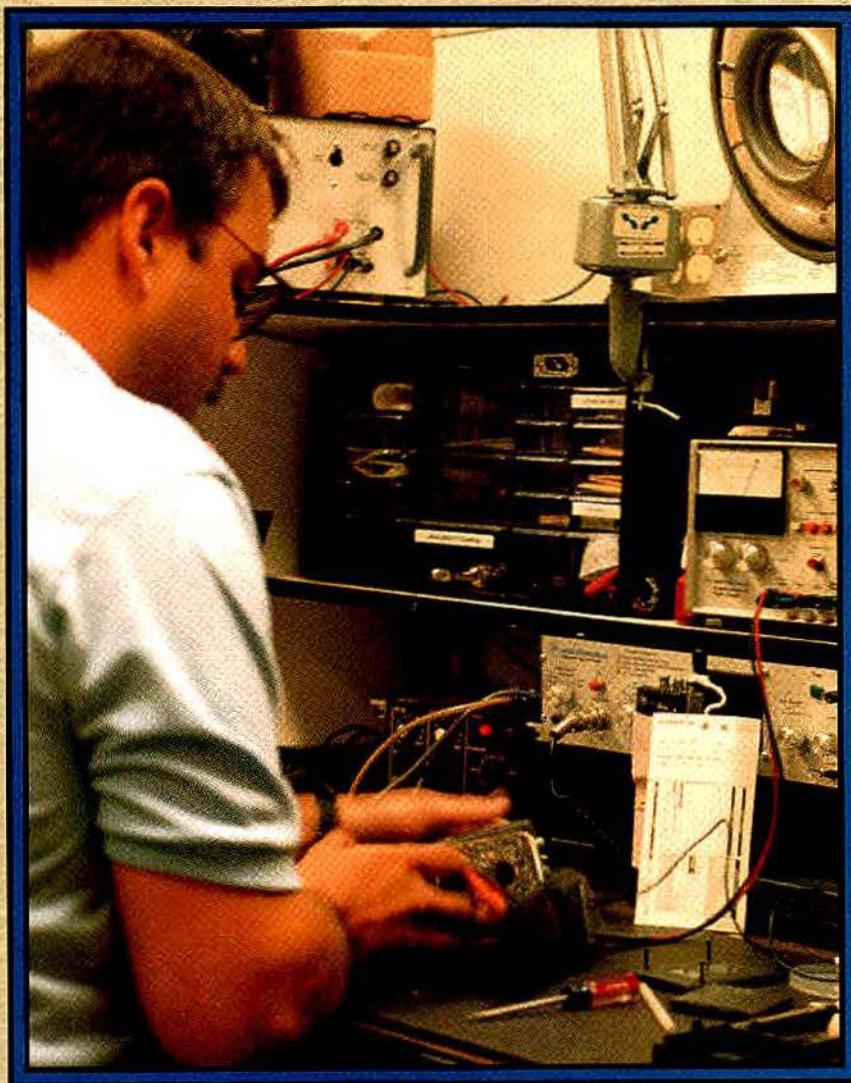


November 1994/\$3

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The journal of mobile communications technology



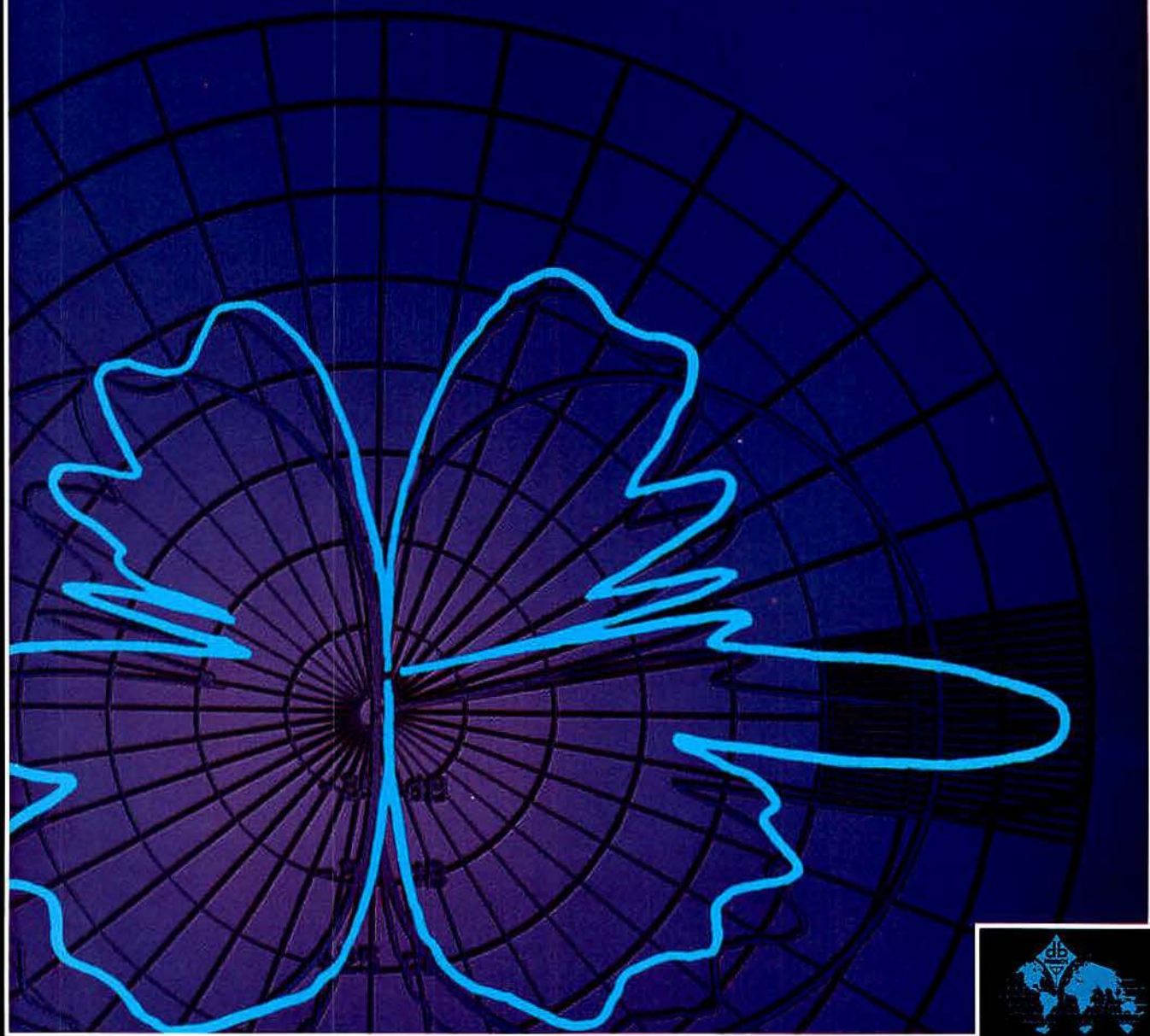
## Duplexers, p. 10

- Antenna testing
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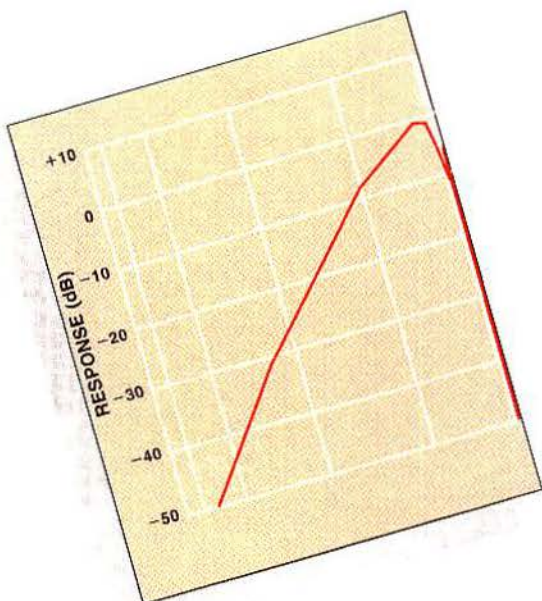
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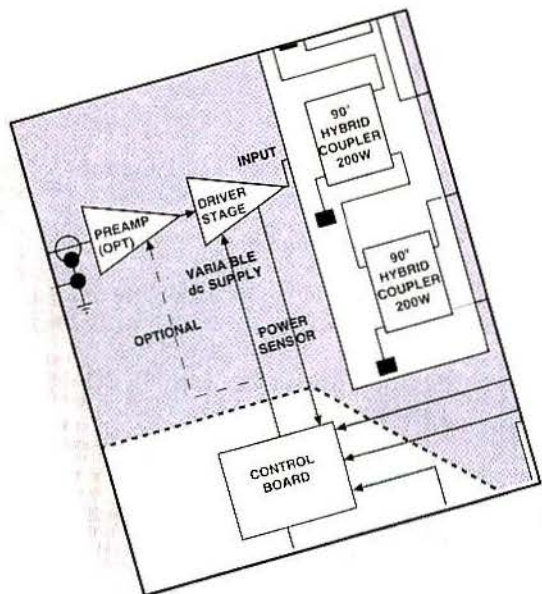
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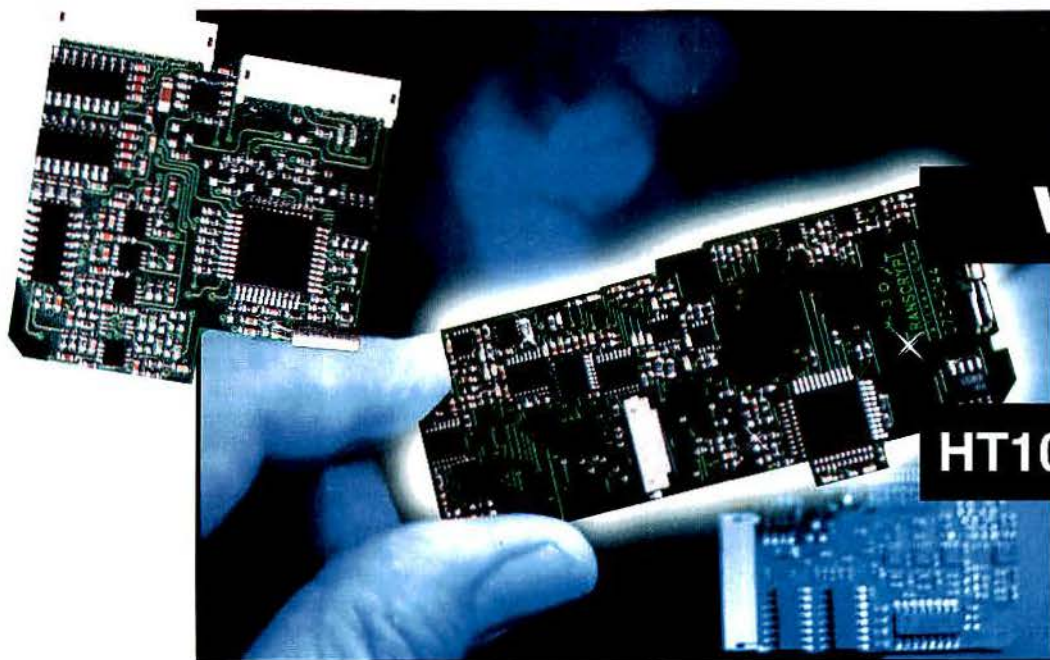
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On the cover: Field service technician, Eric Blumer, repairs a portable transceiver at the Motorola Service Center in Pittsburgh.



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## Small SMR service companies organize to regain access to frequencies



Every so often, a threat to their businesses at the hands of the FCC jolts radio communications service company owners into forming the nucleus of a new trade association to protect their interests. Several years ago, the motivation was the FCC's imposition of monopoly frequency coordination. The association formed to meet that challenge never found its voice.

### The freeze

What has service company owners incensed this time is the FCC's moratorium (known as a "freeze") on issuing new 800MHz specialized mobile radio licenses. The halt in licensing is bad enough, but the freeze might be followed by dismissal of thousands of pending license applications and an auction of the frequencies connected with those applications. If so, many applicants would lose substantial investments, and those intending to use the additional frequencies to expand existing services could see their businesses falter instead.

Such an action could be followed by legal challenges that might prevent new licenses from being issued for years. Even if the service company owners were to mount a successful court battle, victory could come too late.

### Big-money motivation

By the way, this FCC action is motivated by some big money. The commission is flush with success in the auction of narrowband personal communications services (PCS) and interactive video and data service (IVDS) frequencies for nearly three-quarters of a billion dollars—five or six times the amount of its annual budget. This stack of gold far outweighs assessing fines to multiple licensees for tower light violations, even at \$250,000 a

tower. Big fines previously were seen as a big money-maker, but no more. Besides, a federal court ruled July 12 that the FCC adopted its inflated fine schedule illegally. The agency may attempt to reinstitute large fines by a legal process, but for now, its focus is on radio-frequency spectrum auctions.

Money that the FCC collects goes directly into the U.S. Treasury; in other words, the commission does not get to keep it. Nevertheless, the enormous revenue from spectrum auctions makes the agency look good to Congress, which sets the FCC's budget annually.

The big money attracts so much attention that the FCC is willing to consider finding a way to backtrack on its established SMR licensing procedure and sell already applied-for channels to the highest bidder.

### SMR-cellular service

The commission already made a mess of the 800MHz channels, originally intended for dispatch communications, by granting thousands of licenses for what amounts to cellular telephone service on SMR frequencies and giving the SMR-cellular applicants five years to build their systems. Many of the facilities granted by these licenses may never be built, depending on the state of the competition among cellular, SMR-cellular and PCS companies years hence.

Meanwhile, operators of SMR service companies such as Neal F. Ragan of Ragan Communications, Peoria, IL, find themselves cut off from frequencies for expansion. Even in rural Illinois, Ragan told us, hundreds of channels are assigned to systems that are never expected to be built. He admits to having been inattentive while these licenses were granted.

"I never thought that a rural area with 5,000 potential customers would draw applications for 130 channels," he said. "There is no way that so many systems will be built to serve so few potential customers." Even so, Ragan's application to expand his five-channel system has languished on a waiting list for nine months on the way to five years, before unconstructed system licenses would be cancelled, making room for his expansion—that is, unless his pending application is dismissed after the freeze.

### Organizational meetings

Ragan sent letters to other SMR service company owners, and the letters attracted 70 of them to an Aug. 27 meeting in Peoria to discuss steps to take. About

half as many later made the trek to Washington, DC, on Sept. 13 and 14 to visit the FCC and to continue to organize.

The formation of an organization named SMR Won resulted. SMR Won seems to be a temporary organization with the specific goal of blocking any FCC plan to auction 800MHz SMR spectrum and, if possible, freeing some of the spectrum in rural areas for licensing to current system operators that are ready to expand. We say "seems to be" because, as with any fledgling organization, SMR Won's leaders and members are not necessarily of one mind in defining the organization's scope.

SMR Won ought to become an ongoing, if lean, trade association dedicated to representing small radio service companies. These companies need a representative to monitor federal government actions for potential trouble even when company owners are occupied with the daily tasks of running their businesses. They need an organization dedicated to their small businesses and not subject to a conflict of interest in also representing big businesses.

### Adequate representation

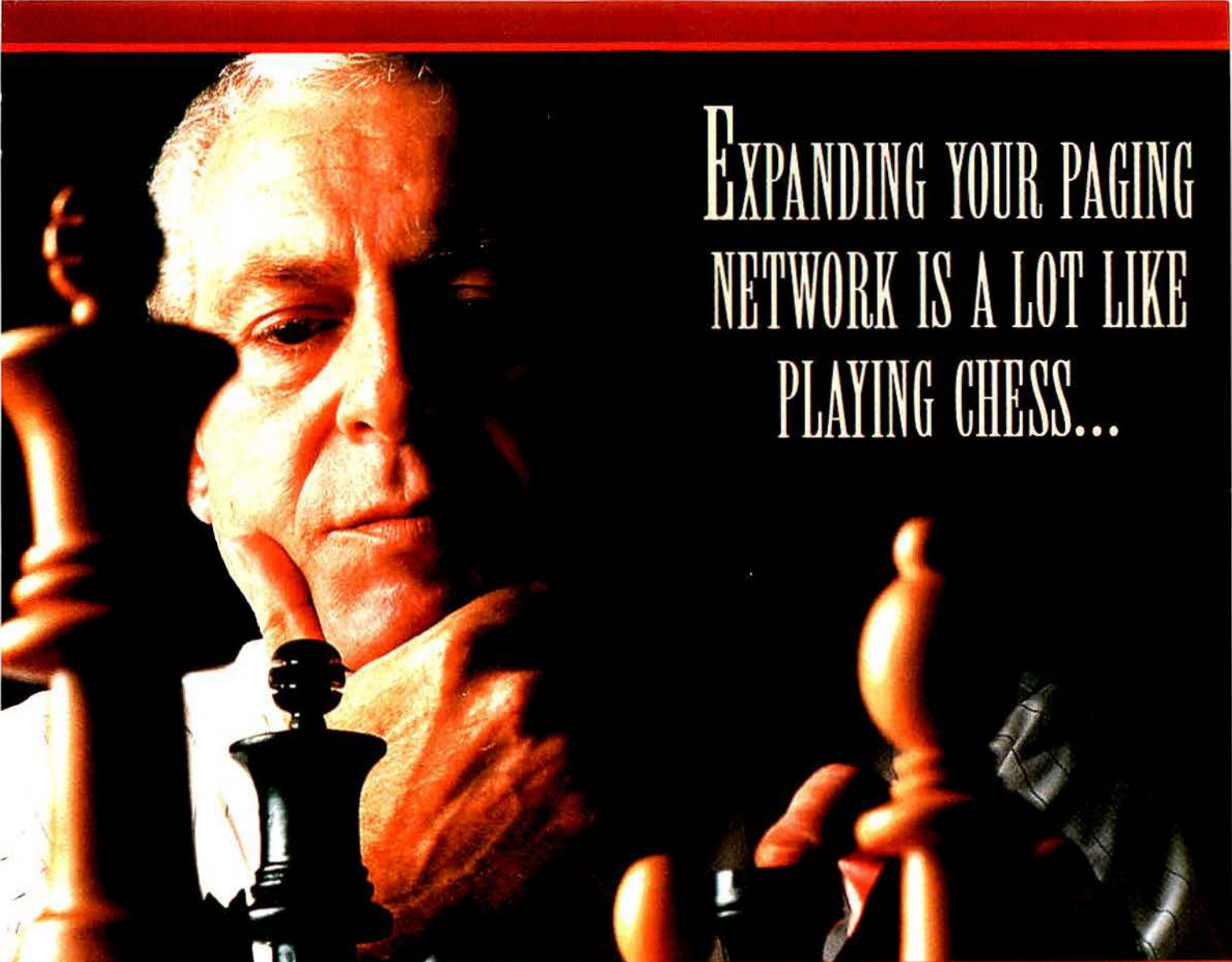
Don't get us wrong. Big business deserves and is entitled to representation. But when small businesses are represented by the same organizations that include big businesses that pay the greater part of the operating budget, they cannot always expect to have their interests reflected in positions taken before the FCC and Congress. These small SMR service companies might not have been foreclosed from expansion if their interests had been adequately represented.

Today (Oct. 3), no one knows whether SMR Won will fight the commission or try to persuade, cajole and buddy-buddy the agency into maintaining and accelerating their ability to expand their systems on frequencies originally intended for that purpose. An eleventh-hour effort doesn't seem to call for too much subtlety, though. More importantly, it is difficult to tell whether the new organization's nerve and resources will be a match for the task at hand.

Information about SMR Won is available from the organization's secretary, Harold O'Dell of La Flore Communications in Greenwood, MS. A request can be sent by fax to 601-453-6079.

—Don Bishop



A black and white photograph of a middle-aged man with a serious expression, resting his chin on his hand. He is surrounded by large chess pieces, including a king and a queen, which are slightly out of focus in the foreground and background. The lighting is dramatic, with strong highlights and deep shadows.

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## November

**3-5—Industrial Telecommunications Association and Council of Independent Communication Suppliers Annual Meetings**, The Kingsmill Resort and Conference Center, Williamsburg, VA. Contact: Barbara J. Levermann, 703-528-5115.

**10-13—Communications Marketing Conference**, sponsored by the Communications Marketing Association, Radisson Plaza Lord Baltimore Hotel, Baltimore, MD. Contact: Jack Armstrong, 410-628-9300.

**18—Radio Club of America, Communications Symposium**, 85th Anniversary Dinner and Awards Presentation, New York Athletic Club, New York. Contact: Ron Formella, 201-652-6811.

## December

**6-8—Wireless Datacomm Fall**, Washington Convention Center, Washington, DC. Contact: 800-322-9332.

## 1995

## January

**16-18—Mobile Communications Conference**, sponsored by Frost & Sullivan, Westin Hotel, Galleria Dallas, Dallas. Contact: 800-256-1076.

## February

**1-3—Cellular Telecommunications Industry Association Winter Meeting and Exposition**, New Orleans. Contact: 202-785-0081.

## March

**13-14—AMTEX**, the American Mobile Telecommunications Association's Marketing and Technology Conference and Exposition, The Buttes, Tempe, AZ. Contact: 202-331-7773.

**16-17—Government Land Mobile Communications Conference**, sponsored by TMSA Conferences, Rosslyn Westpark Hotel, Arlington, VA. Contact: Steven Silver, 310-534-4871.

**20-23—Supercomm**, sponsored by USTA and TIA, Anaheim Convention Center, Anaheim, CA. Contact: 202-326-7300.

## April

**3-5—Energy Telecommunications and Electrical Association**, George R. Brown Convention Center, Houston. Contact: 214-235-0655.

**25-27—International Wireless Communications Expo/Spring**, Las Vegas Sands Convention Center, Las Vegas. Contact: 800-828-0420.

## May

**17-19—Mobile Communications Conference**, sponsored by the National Association of Business and Educational Radio (NABER), Hotel del Coronado, San Diego. Contact: Nancy Palleschi, 800-759-0300.

**31-June 2—Radiocomm**, Toronto Metropolitan Convention Center, Toronto. Contact: 613-233-4888.

## July

**26-28—Vehicular Technology Conference**, sponsored by IEEE Vehicular Technology Society, Hyatt Regency Chicago O'Hare, Chicago. Contact: Keith Paglusch, chairman, 312-399-2378.

**31-Aug. 4—Utilities Telecommunications Council**, Hyatt Regency and Convention Center, Minneapolis. Contact: 202-872-0030.

## August

**13-18—Association of Public-Safety Communications Officials—International National Conference**, Detroit. Contact: 800-949-2726.

## September

**20-23—Personal Communications Showcase**, sponsored by the Personal Communications Industry Association (PCIA), Orange County Convention Center, Orlando, FL. Contact: 800-326-8638.

## October

**18-20—International Wireless Communications Expo/Fall**, Tampa Convention Center, Tampa, FL. Contact: 800-828-0420.



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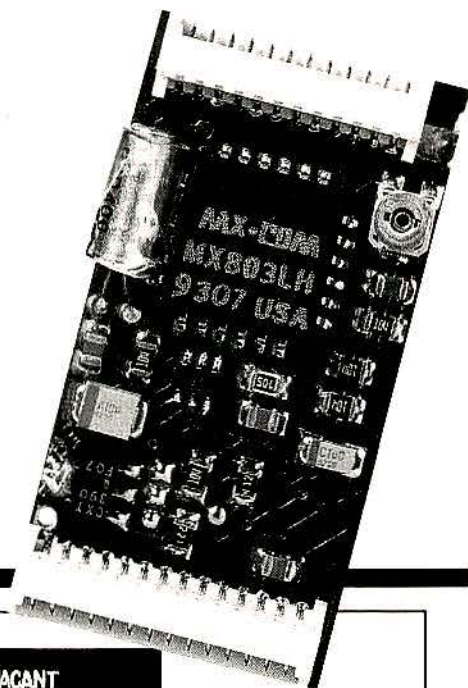
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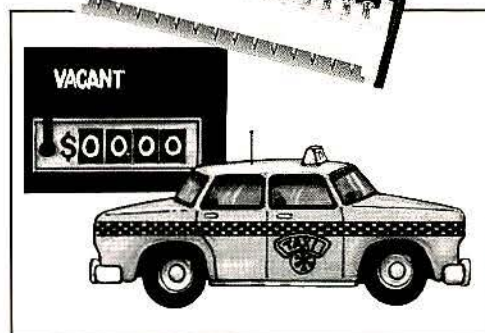
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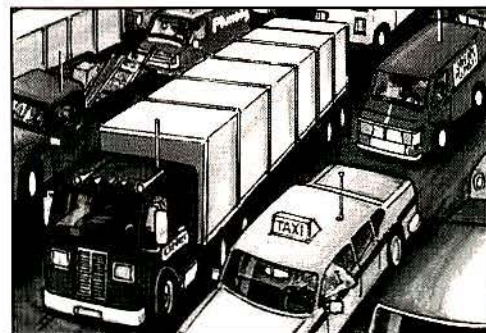
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## Telephone line-testing basics, part 2

By Harold Kinley, C.E.T.

Last month, we covered noise measurements on telco (telephone company) lines and some of the equipment used to make such measurements. Some of the same equipment and techniques are used to make many other pertinent telco line tests and measurements. The following information covers some of the other test procedures and methodology.

### Line loss and frequency response

A typical non-conditioned (type 3002) line used to remotely control two-way radio base stations has a loss of  $16\text{dB} \pm 4\text{dB}$  long-term variation from end to end. This loss is measured at  $1.000\text{Hz}$ . (Telco usually uses  $1.004\text{Hz}$  as the reference point.)

This variation means that the line loss can be as little as  $12\text{dB}$  or as much as  $20\text{dB}$  at any given time. Any loss greater than  $20\text{dB}$  should be reported to telco for repair. Figure 1 below shows the simple setup used to check the line loss. It is important to use equipment with balanced input/output connections. Connecting unbalanced equipment to the line will create problems and can invalidate the measurements. Telephone line test equipment often is battery-operated to isolate the equipment from ground.

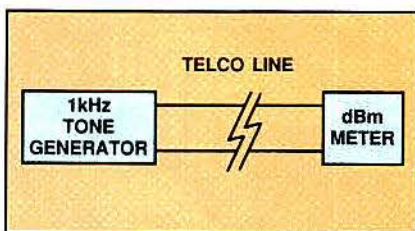


Figure 1. This simple setup can be used to measure line loss and frequency response.

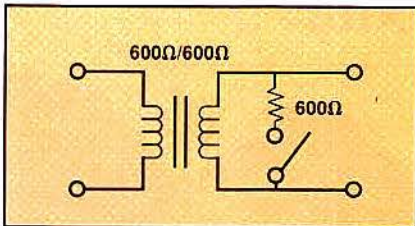


Figure 2. This simple transformer arrangement can be used to connect unbalanced instruments to the line without unbalancing the line. The termination resistor ( $600\Omega$ ) is connected to the measure side of the transformer. This arrangement can be built inside a small construction box with input and output connectors for convenience.

Transformers ( $600\Omega/600\Omega$ ) usually are used to connect unbalanced equipment inputs/outputs to the telephone line. Last month's column explained how to build a simple isolation transformer in a small construction box to facilitate the connection of unbalanced test equipment to the telephone line. The simple diagram is shown in Figure 2 bottom left. The  $600\Omega$  load resistor usually is used on the measuring end to properly terminate the line for measurement.

The graph in Figure 3 below is handy for converting between decibels referenced to a millivolt (dBm) and root-mean-square (rms) voltage across  $600\Omega$ . With the equipment set up as shown in Figure 1, the tone generator is set to produce a  $1\text{kHz}$

tone at  $0\text{dBm}$  or  $0.775\text{Vrms}$ . If a dBm meter is not available, use a good-quality (battery-operated) digital voltmeter (DVM) to measure the  $1\text{kHz}$  audio level at the end of the line. If the line loss does not exceed  $20\text{dB}$  (and it should not), the minimum voltage that will be measured at the end of the line is  $0.0775\text{V}$  or  $77.5\text{mVrms}$ . A good-quality DVM should be able to

(continued on page 50)

Kinley is a certified electronics technician with the South Carolina Forestry Commission, Spartanburg, SC. He is the author of *Standard Radio Communications Manual: With Instrumentation and Testing Techniques*. Prentice-Hall, 1985.

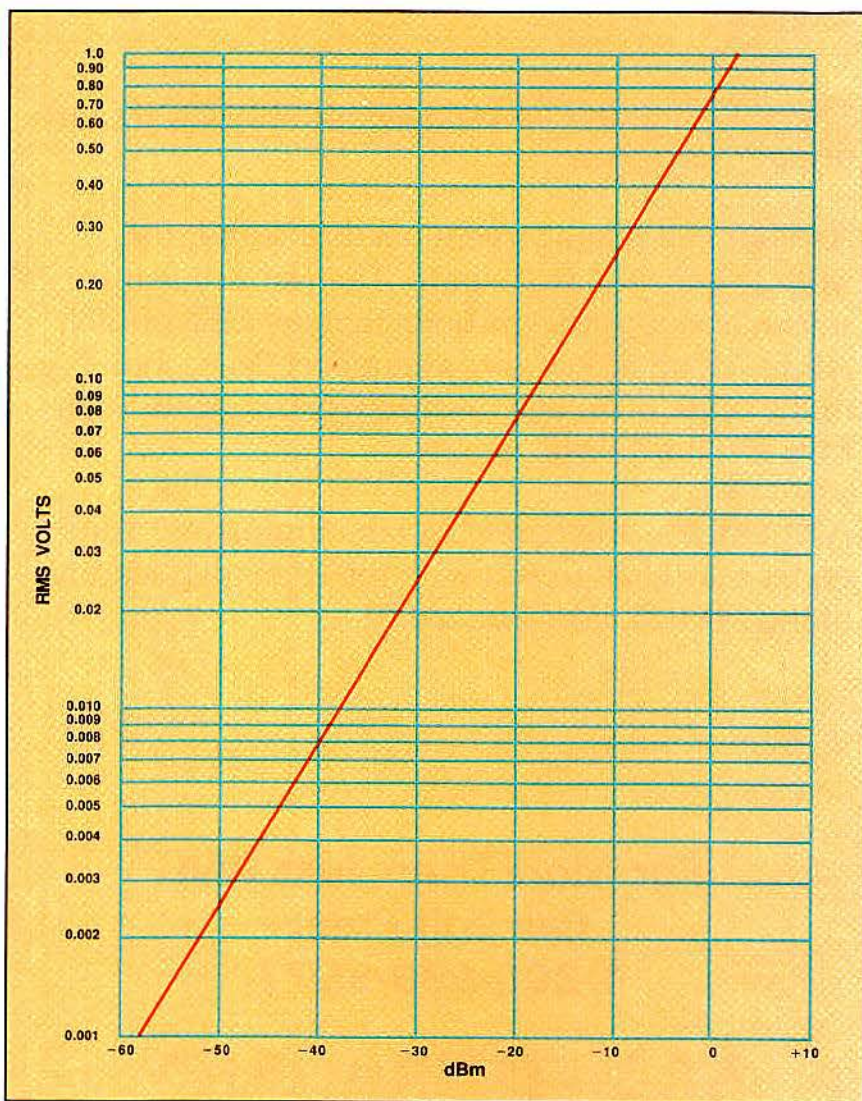


Figure 3. This graph can be used to convert between dBm levels and rms voltage levels across  $600\Omega$  impedance.



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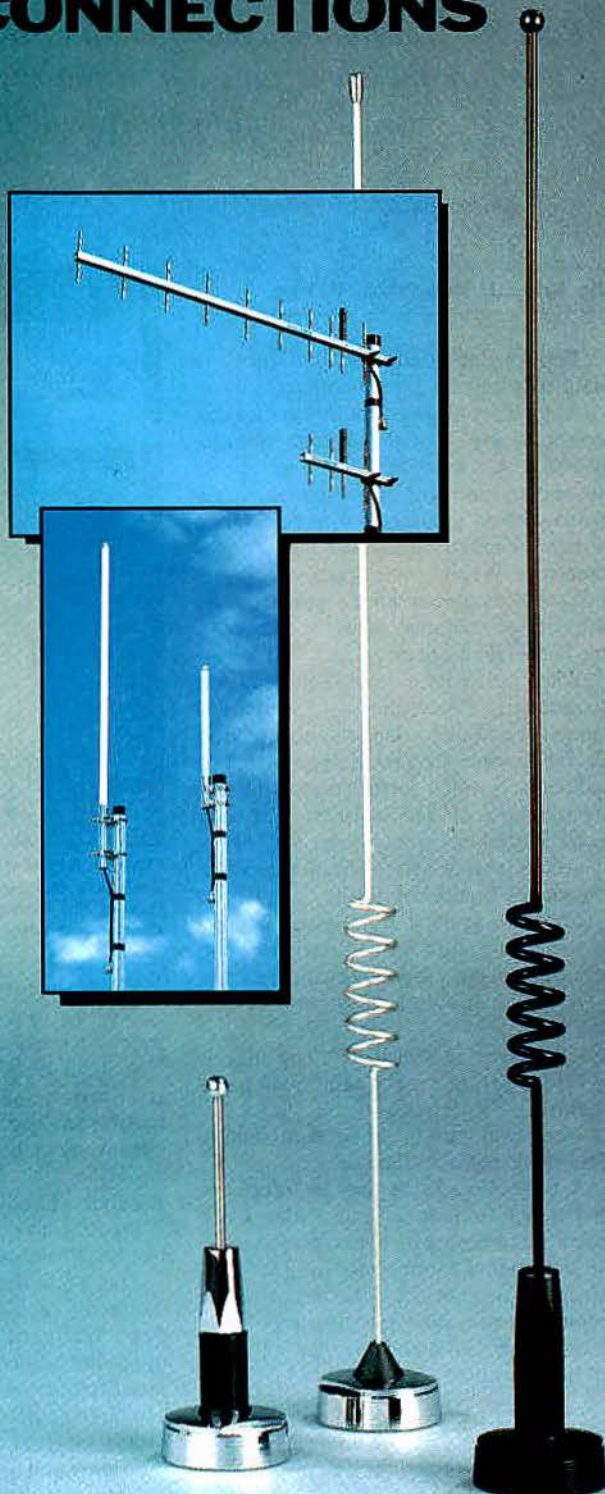
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# How to use duplexers: Combiners, multicouplers

*Part 5—Transmitter combiners and receiver multicouplers allow multiple repeaters to share the same antenna. If the system can tolerate the energy loss, combiners allow more efficient use of antenna space.*

By Brian J. Henderson, P. Eng.

Transmitter combiners and receiver multicouplers are filter configurations.

A duplexer allows a transmitter and receiver to use a single antenna simultaneously. A transmitter combiner allows several transmitters to use the same antenna without interfering with each other; a receiver multicoupler does the same for receivers. Where tower space is at a premium, a combiner and a multicoupler may allow additional radios to use previously installed antennas.

When interference occurs between some transmitters or receivers at a radio site, a combiner and multicoupler system reduces the interference. Interference is common on radio towers with separate antennas for each repeater system. The isolation of a combiner and multicoupler system may be required to prevent intermodulation products (intermod) from occurring.

Combiner systems have losses. A combiner system allows additional transmitters and receivers to use the same antenna.

A combiner system may be warranted if:

- the tower is loaded with antennas.
- interference between systems is occurring.
- the tower must be rebuilt to accommodate more radio systems.

A combiner system may be expensive and it may introduce system losses that affect radio coverage. These factors must be considered before installing a combiner option. On the other hand, using combiners may cost less than rebuilding a tower to accommodate more antennas or radio systems.

Henderson is senior engineer, communications, with Canadian Western Natural Gas, Calgary, Alberta.

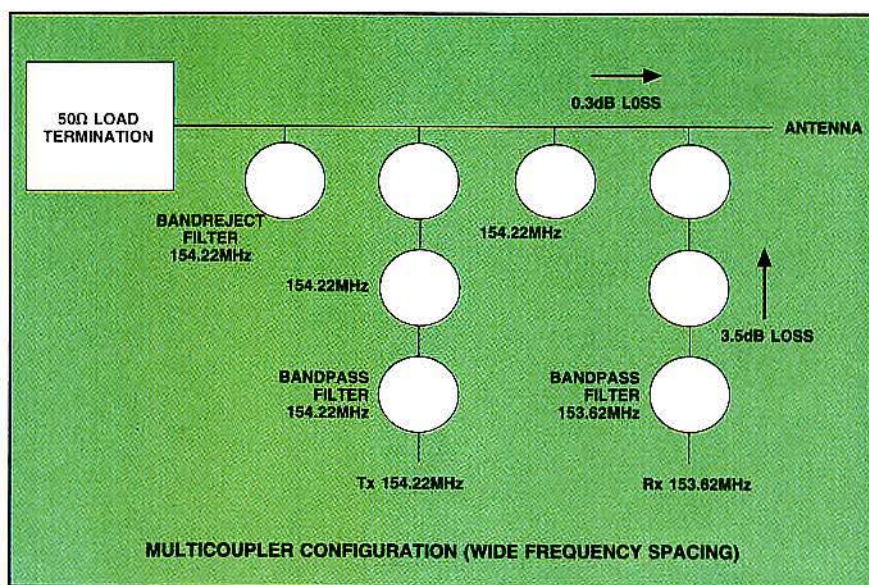


Figure 1. A typical bandpass/band-reject combiner is configured as shown. It includes two or three bandpass cavities and one reject cavity per frequency. Because of the combiner's bandpass nature, the minimum frequency separation is 2MHz. For closer frequency spacing, use the bandpass/isolator type of combiner configuration.

There are two basic combiner types.

Whether to use either depends on transmitter and receiver frequency spacing.

As with duplexers, a combiner's purpose is to provide sufficient isolation between transmitters and receivers so that they operate without mutual interference.

## Bandpass/band-reject combiner

Figure 1 above is a general drawing of a bandpass/band-reject combiner.

This combiner type has two or three bandpass cavities and one reject cavity per frequency. Because of the combiner's bandpass nature, the minimum frequency separation is 2MHz. For closer frequency spacing, use the bandpass/isolator type of combiner configuration.

Note as well that each "leg" of the sys-

tem has approximately 3.5dB of loss plus 0.3dB system loss between each connection point and the antenna. That loss is why receivers are placed on the "string" first, followed by the transmitters. The idea is to reduce loss between the antenna and receiver.

Tuning these combiner strings consists of tuning individual bandpass and band-reject cavities. Once tuned to the correct frequency using a transmitter and wattmeter as described above, the combiner can be installed. Remember to terminate all unused ports with a 50Ω load.

The combiner can be expanded to add more transmitters and receivers. Figure 1 shows one section of a combiner string. This section allows one transmitter and one receiver to operate.

Adding another eight individual cavities



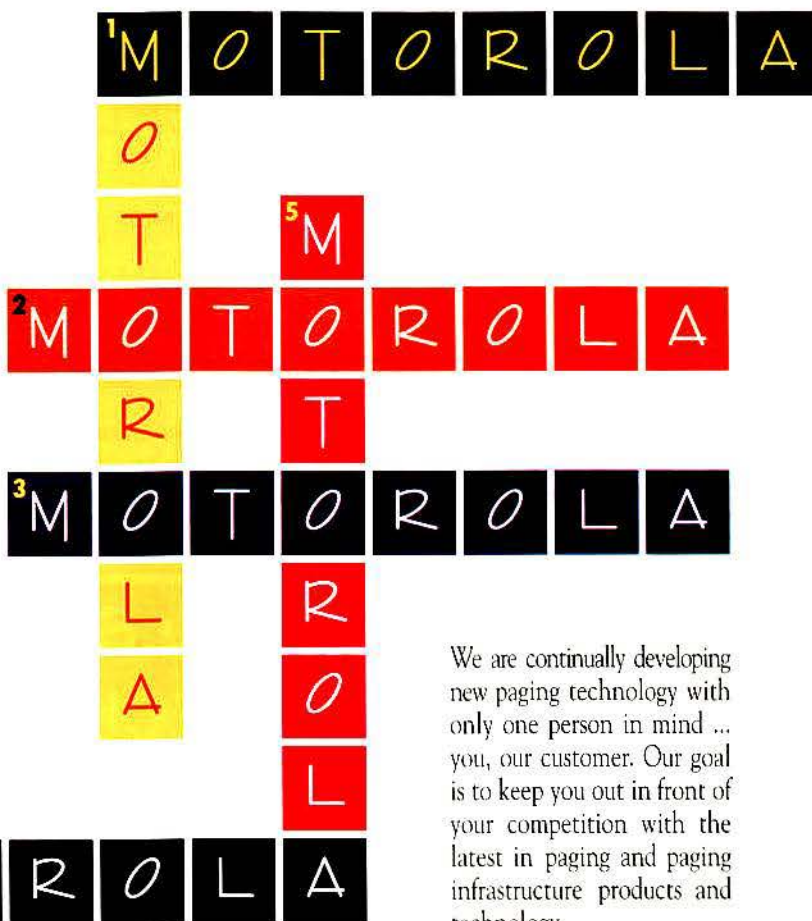
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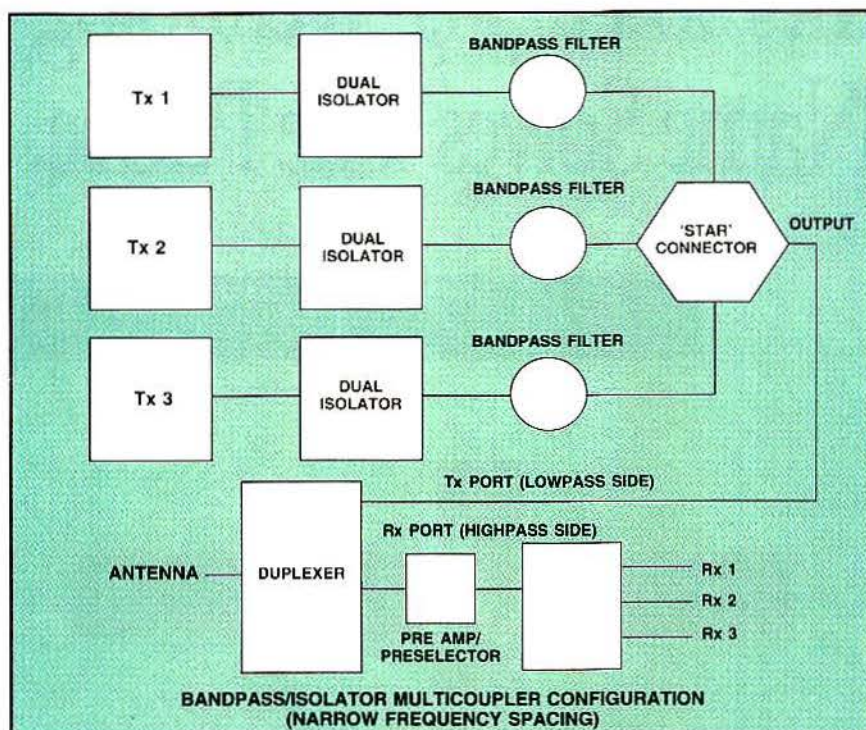


Figure 2. A typical bandpass-isolator combiner is configured as shown. It can be used for frequency spacings closer than 2MHz. An operational limit is a minimum spacing of 500kHz at VHF and 300kHz at UHF. For cellular use, channel spacing as close as 250kHz is possible.

and moving the 50Ω load termination to the rear of the combiner string allows one more transmitter and receiver to be added. Remember to connect the receivers ahead of all transmitters to minimize loss between the antenna and receivers.

The string can be expanded to accommodate as many as four transmitters and four receivers on a single antenna. This is a practical limit because of loss.

The last transmitter in the combiner string (just before the load termination) will experience  $8 \times 0.3\text{dB} + 3.5\text{dB} = 5.9\text{dB}$  of loss. More transmitters can be added if the system can tolerate the loss. Normally, four is the maximum number of repeaters used because of the loss.

#### Bandpass-isolator combiner

The bandpass-isolator type of combiner combination can be used for frequency spacings closer than 2MHz.

An operational limit is a minimum spacing of 500kHz at VHF and 300kHz at UHF. For cellular use, channel spacing as close as 250kHz is possible. Figure 2 to the left is a drawing of a typical bandpass-isolator combiner configuration.

Several frequency restrictions apply to using this combiner type:

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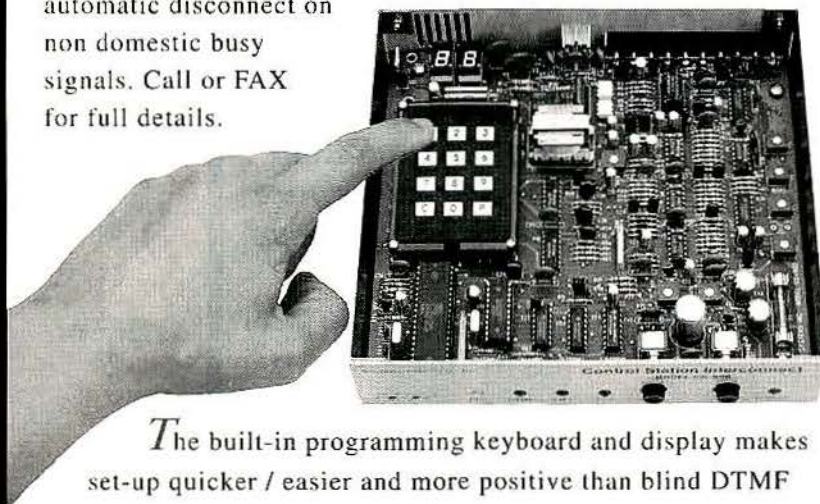


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(1) The minimum frequency spacing is 500kHz at VHF and 250kHz at UHF.

(2) All transmit frequencies must fall into the passband on one side of a duplexer.

(3) All receive frequencies must fall into the passband on the other side of the duplexer.

(4) Frequencies cannot be scattered throughout a given VHF or UHF frequency band.

There are four basic components to this type of combiner:

- (1) ferrite isolator.
- (2) bandpass filter.
- (3) duplexer.
- (4) receiver multicoupler.

The duplexer's purpose is to separate the transmitter frequency group from the receive frequency group. The duplexer can be either type, depending on the overall transmitter and receiver frequencies' band-

width requirements.

Transmitters are connected first to a dual isolator, then to a bandpass filter. From there, they are connected to a "star connector," which is similar to a "T" connector except with four or more connection ports. Several cables can be connected in parallel because they represent several circuits connected in parallel with a 50Ω circuit. There is no effect on the impedance at a particular frequency. Note also that unused ports should be left open rather than terminated to preserve isolation and impedance.

## Tuning

The bandpass-isolator combiner has only two components that can be tuned in the field.

First, the duplexer can be tuned as described for the type and configuration of the duplexer in use. The bandpass filter can be tuned in the conventional manner as described above for bandpass cavities.

Ferrite isolators should not be adjusted. They usually have enough bandwidth to use without tuning.\*

The receiver multicoupler is made of a bandpass network, an amplifier and splitter. The only component that can be adjusted is the bandpass network, if required. The bandwidth usually is quite wide, so adjustment may or may not be necessary depending on how much frequency shift there is among all receivers.

Try injecting signal into a receiver through the receiver multicoupler. If the receiver operates with reasonable sensitivity, leave the bandpass filter alone. If it works, don't fix it.

## Duplexer

When combining several transmitters and receivers in this way, it still is necessary to provide separation between the transmitter and receiver groups of frequencies. The easiest way to do this is with another duplexer. Still, make sure that transmitter and receiver frequencies fall into a group that can be separated by a duplexer.

As an example, consider a system with the following operating frequencies:

SYSTEM	TRANSMIT FREQUENCY (MHz)	RECEIVE FREQUENCY (MHz)
1	413.1000	418.1000
2	413.3000	418.3000
3	413.5000	418.5000
4	413.7000	418.7000

In this case, all transmitter frequencies fall into the 413.1000MHz-413.7000MHz

\*See "Technically Speaking" by Harold Kinley, C.E.T., in the June and July 1993 issues.

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range. Receive frequencies fall into the 418.1000MHz-418.7000MHz range. A bandpass-style duplexer with a 600kHz passband bandwidth will work fine.

A spectrum analyzer and tracking generator must be used to align this duplexer. Adjust for required passbands on both the transmit and receive sides.

If frequencies are scattered throughout the band, it is not possible to use this multi-coupling system type. There are no other

alternatives besides separate antennas.

#### Shipping and handling

You have a duplexer or combiner tuned up and ready to travel to the site. You have made sure that all adjustments are locked and tightened. You throw it in the back of the truck, and off you go. You get to the site, install it and find that it does not work. Now what?

Two things can happen to duplexers or

combiners in transit to detune them.

All tuning rods on duplexers have either a set screw or a locking nut to tighten their adjustments. Capacitors do not. They can move if bounced around or jarred. When they move, the cavity is detuned.

The other thing that can happen is that the tuning rod can shift inside the cavity. When it does, the filter is detuned.

The rule is, take it easy with the equipment. It is fragile. If you have the original packing material and shipping crates, use them. Wrap all filters in foam rubber pads to cushion them when driving up the bumpy road to the radio site.

A temperature change may be a factor, too. Filters transported in winter may be cold when they arrive at the site, so let them warm up for 15-20 minutes before installing them. A small change in temperature can detune cavities. Once their temperature stabilizes, the filters should be back into proper tune.

A further note on temperature: Filter detuning is evident when filters are *operating* during extreme temperature changes. During *shipping*, temperature changes do not affect them. Once the filters return to room temperature, they should operate as specified.

#### Summary

There are many types of duplexers, cavities and isolators that can be used for transmitter and receiver isolation. The methods described in these five articles will assist with retuning cavities to provide the desired function with the antenna system.

(This concludes the article series.)

#### Duplexer series

Previous installments in this article series include:

- "How to use duplexers: Isolation Requirements" in the July 1994 issue.
- "How to use duplexers: The various types" in the August 1994 issue.
- "How to use duplexers: Installing and tuning" in the September 1994 issue.
- "How to use duplexers: Fine-tuning adjustments" in the October 1994 issue.
- "How to use duplexers: Combiners, multicouplers" in the November 1994 issue.

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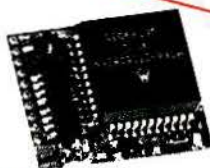
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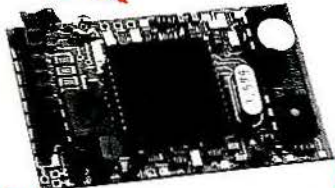
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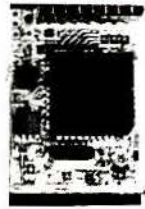
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# Use antenna analysts to simplify testing, adjustment

*Antenna analysts that automatically plot standing wave ratios across a frequency range and display the information as a liquid crystal display graph make antenna testing and adjusting easier and faster.*

By Terry Perdue

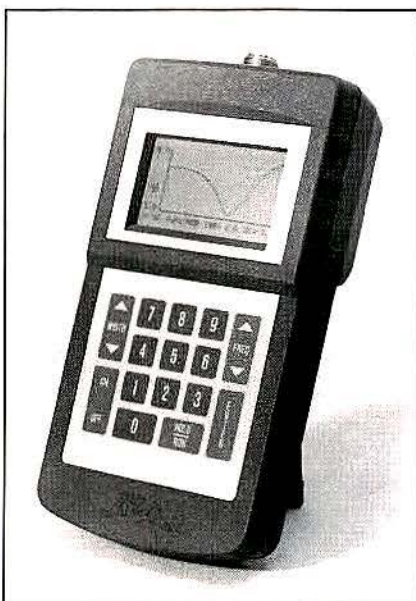
A well-matched antenna system is important to communications system efficiency. A mismatched antenna (one with a different input impedance than the characteristic impedance of its feedline) causes some of the radio frequency energy delivered to it to be reflected back down the transmission line. This results in standing waves and energy being lost to dielectric heating. The voltage standing wave ratio\* (VSWR) is the ratio of the sum of incident and reflected voltages over their difference. In terms of forward and reflected power, VSWR is defined as:

$$VSWR = \frac{1 + \sqrt{\frac{\text{reflected power}}{\text{forward power}}}}{1 - \sqrt{\frac{\text{reflected power}}{\text{forward power}}}}$$

An optimum VSWR of 1:1 results when the reflected power is reduced to zero.

Most antenna systems are vulnerable to damage and degradation by virtue of their location. Exposure to the elements invites rust, corrosion, breakdown of dielectrics, and bent or broken parts.

A traditional method for verifying antenna system performance is to place a standing wave ratio (SWR) bridge or directional wattmeter in the feedline, apply



An SWR-121 antenna analyst from Advanced Electronic Applications.

RF energy at an appropriate frequency, and check for a reasonable impedance match. To determine the antenna's characteristics over a range of frequencies, this process can be repeated at a number of frequencies, and the results can be plotted manually.

Most SWR bridges require at least a few watts of power to make an accurate measurement, which makes it a good practice to check the measurement frequencies for activity first, to avoid interference and to complete the test as quickly as possible. If any adjustments are required, the whole process can become tedious and time-consuming.

An antenna analyst is a piece of test equipment that provides a means of greatly simplifying the processes of verifying, optimizing and documenting antenna performance. One such analyst covers 1MHz

to 32MHz, and another covers the 120MHz-175MHz, 200MHz-225MHz and 400MHz-475MHz bands. Each one includes a synthesized RF source, a sensitive SWR bridge and a graphical LCD (liquid crystal display) in a self-contained package. The user selects a frequency range, and the analyst plots the SWR automatically within seconds. The speed of measurement and low power used (about 5mW) make interference to other services unlikely.

The analyst's portability makes it convenient to carry up a tower to take measurements, and to make any necessary adjustments, in a single trip. A flip-out bail, which I refer to affectionately as the "Gumby foot," may be bent into a hook shape to hang the analyst on a tower crossbar. Making measurements right at the antenna removes any effects produced by the feedline.

The plot can be saved for a short period by pressing the HOLD button. Once the instrument is back on the ground, the plot can be saved permanently on a personal computer (PC) and printed for later comparison, using a cable and software available as an accessory. The software also allows real-time display on the PC screen. Each analyst also can be controlled remotely using any ASCII (American Standard Code for Information Interchange) terminal or PC running terminal emulator software, and the SWR can be read at any frequency in its range.

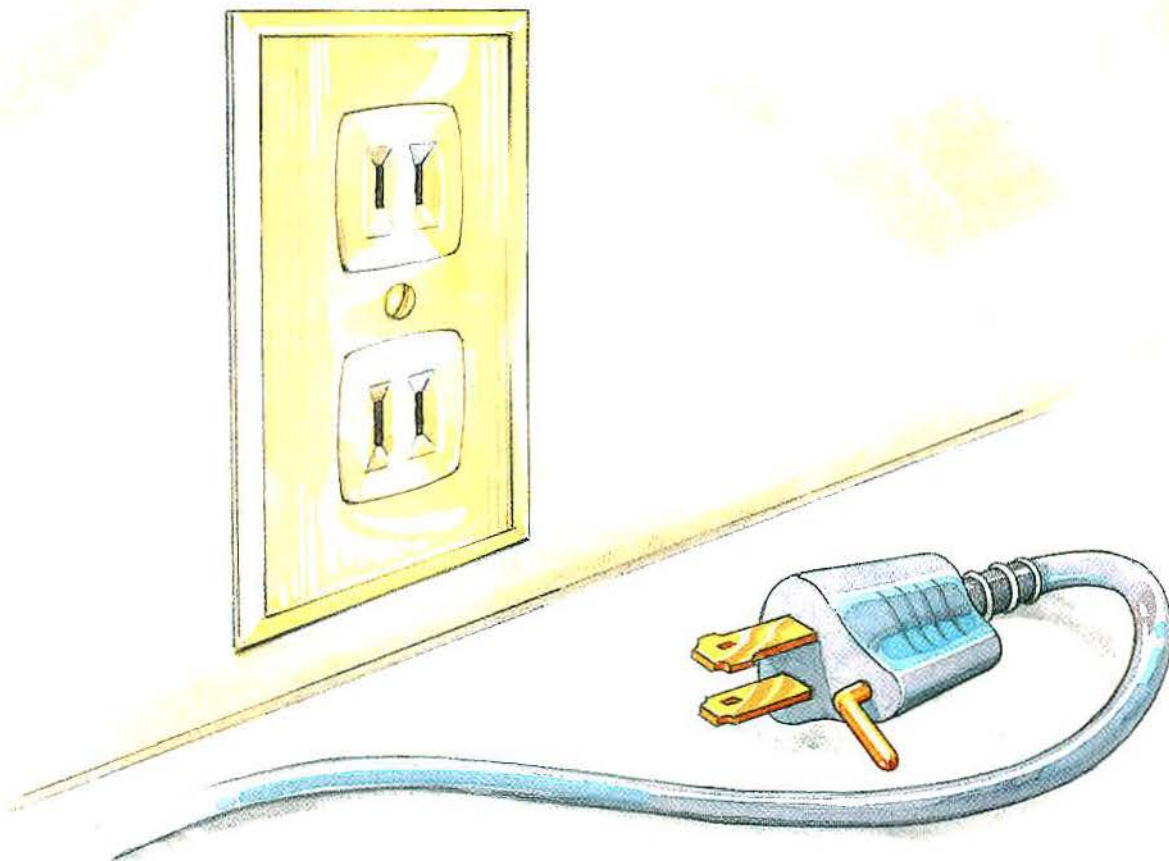
Antenna adjustments at a single frequency are simplified by entering zero as the display width. The plot speeds up, and an internal beeper chirps at a frequency that is proportional to SWR so the user can concentrate on the task at hand without having to keep referring to the display.

In normal operation, the analyst makes an initial scan of the selected frequency range before it starts plotting. This func-

\*A VSWR measurement provides an indication of impedance matching.

Perdue is senior design engineer at Advanced Electronic Applications, Lynnwood, WA. The antenna analysts described in this article are models SWR-121 (HF), SWR-121 V/U (VHF and UHF) and 150-400 (150MHz-400MHz).





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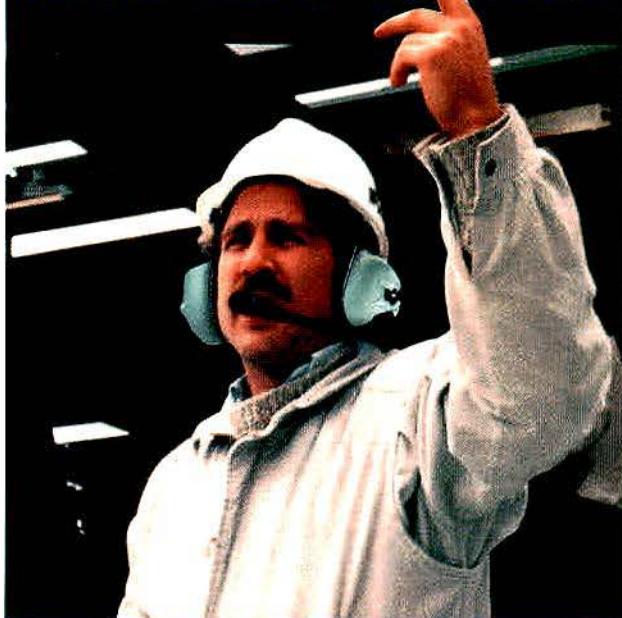
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tion allows it to find the highest SWR within that range and to scale the plot accordingly for the best resolution. This function can be turned off, in which case the top of the plot is fixed at 10:1. Once finished with the adjustments, the feature can be turned back on for a final plot. Antenna bandwidth may be measured conveniently using this auto-scale feature. Using a 100Ω resistor as a temporary load, the analyzer scales the top of the display at 2. After replacing the resistor with the antenna, simply measure the bandwidth between SWR = 2 points as the width between the pixels at the top of the plot.

*Another function locates the lowest SWR in the current plot and centers the display on that point. This function makes it unnecessary to perform mental calculations to determine the frequency change required.*

Another function locates the lowest SWR in the current plot and centers the display on that point. This function makes it unnecessary to perform mental calculations to determine the frequency change required. In addition to direct frequency entry, you can enter a frequency increment to be added to, or subtracted from, the current center frequency each time the FREQ. UP button or FREQ. DOWN button is pressed. The plot is 110 times the width represented by each pixel. This width steps in a 1-2-5 sequence when the WIDTH buttons are pressed, or a specific width can be entered.

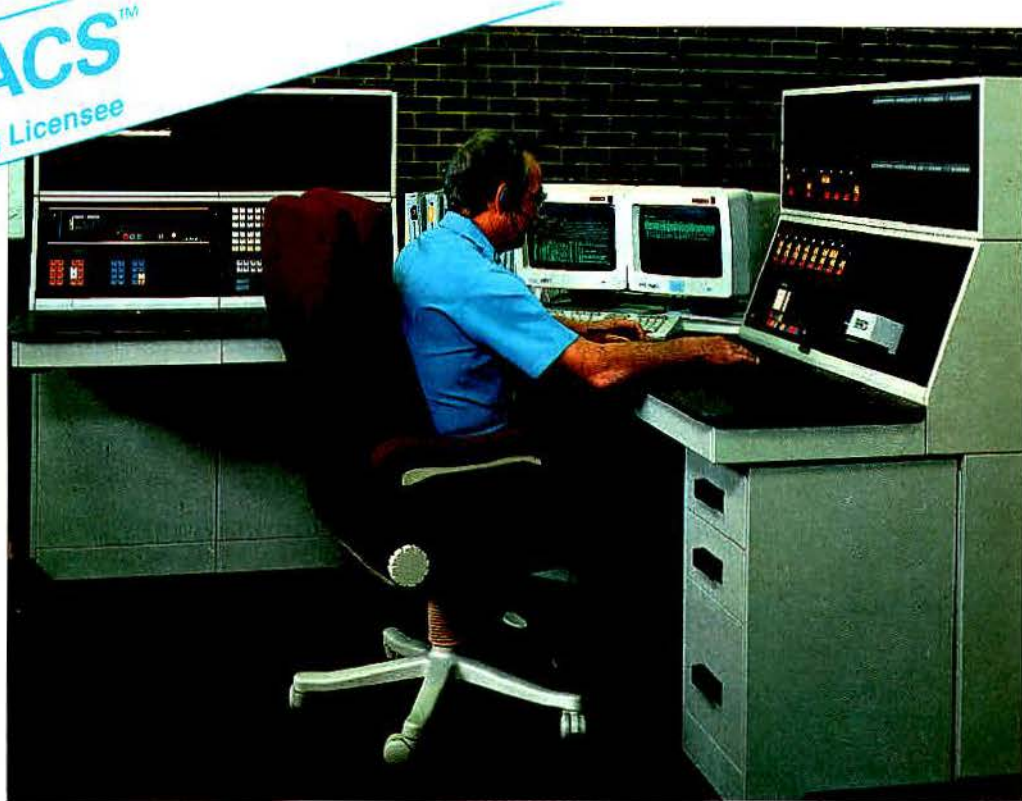
Actual SWR at the center frequency also is shown at the bottom of the display, as are other values: the frequency increment represented by each pixel, the center frequency and the return loss at the center frequency. The return loss readout is useful when checking the loss in decibels of a length of feedline.

An antenna analyzer is a useful tool for antenna maintenance and experiments.





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# Servicing pagers: Microprocessor board

*Part 11—Here's how the versatile Bravo pager microprocessor board performs its tasks in shifting the pager from standby to receive, verifying address reception and displaying messages from electronic memory.*

By David Ludvigson

To this point, we have discussed the various receiver boards for the Motorola Bravo pager. Now we will take a closer look at just how the decoder board operates.

Motorola has made use of "dedicated" microprocessors to handle the decoding functions found in the Bravo. A list printed in Part 3 (March 1994 issue) identifies which chips handle Golay, POCSAG 512 and POCSAG 1,200. Although the formats may differ, programming each subset of chips uses the same microprocessor.

The most obvious difference to the technician is found in the values of RC filters (R101/R201, R102/R202/R302, C101/C201/C301, and C104/C204/C304) and the clock speed (Y101, Y201, and Y301). The RC filter values have been chosen to optimize the frequency response at *rec. audio* (pin 4, J001). The *peak* and *valley* detectors (on the receiver board) detect the level transitions of the audio signal and apply it to the *limiter*. The resulting output is a stream of rectangular pulses.

□ NRN5155A-2 and NRN5156A-2 decoder boards:

Numerous revisions have occurred with the decoder boards.

The NRN5155A-2 and NRN5156A-2 are capable of Golay and POCSAG 512 operation only, and use the 510586Q01 or 510586Q04 microprocessors ('Q01 or 'Q04 in these discussions). Should you ever find a 'Q02 or a 'Q20 for a microprocessor (I never have), these processors serve as a POCSAG 512 chip when installed in these boards.

□ NRN5155A-4, NRN5156A-4, NRN7459A, NRN7463A, and NRN7549A decoder boards:

We will be discussing this series of decoder boards at length.

They are capable of operating Golay, POCSAG 512 and POCSAG 1,200 formats, with the previously noted modifications to the board (i.e., RC filter, clock speed and microprocessor). Our discussion will cover the three basic modes in which this board operates: the "Wake-up!" mode, the "I'm looking for it!" mode and the "Look what I found!" mode.

## The 'Wake up!' mode

Placing a battery in the Bravo and switching it to "on" is just the beginning of its day. (See Figure 1 on page 24, or see Motorola manual 68P81006B85-C, page 15, for more detail.)

Switch S001 is shown in its *full up* (beep) position. B+ (from the nominal 1.5 volt battery) is applied to pin 2 of the switch, one side of L001 and the emitters of Q001-Q004. Power for the *support-interface* chip (U001) is provided through pin 21.

At the far side of L001 is a voltage multiplier that produces 3.2Vdc. This boosted dc is applied to pin 48 of U102 and pin 13 of the codeplug (U004) for operating voltage.

Pin 10 of U001 is fed a *high* voltage by means of the slide switch. This *flag* informs the chip that we expect it to *beep*. If this *high* is missing, the pager will go into the *vibrate* mode.

With the signal output devices having been determined and with the chips having been provided with the required operating voltages, the crystal oscillator (Y001 and associated circuitry) is enabled. The *reset* line (pin 2, U102) is held low until C006 charges. This momentary *low* forces the CPU (U102) and the codeplug (U004) to restart to its lowest address and begin execution of the program stored in the 6K BYTE ROM. From ROM, the program begins.

The oscillator/timer counter advances by increments, starting the process of reading information stored in the codeplug. Line A0 (pin 11, U102) is tested. If it is *high*, peripheral interface adapter (PIA) Port C controls the flow of information *out* of the codeplug (U004) into PIA Port A. PIA Port A strobes the codeplug via A0 (pin 11, U102), reading the stored data via the I/O (pin 10, U102) into A1. These data contain the capcode and the options programmed into the codeplug. This information is stored in internal RAM.

If, for any reason, the program fails to execute properly, the *deadman timer* performs a *reset*. This failure is detected when a *low* is sensed on pin 11 of U102 and

## Pager servicing series

Part 1: "Build a shielded room," January 1994. (All pagers.)

Part 2: "Build an 'IFFER'," February 1994. (Bravo, Bravo Plus, Bravo Express.)

Part 3: "Frequencies, coding formats," March 1994. (Bravo.)

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Part 5: "The receivers," May 1994. (Bravo.)

Part 6: "Elegant simplicity," June 1994. (Bravo.)

Part 7: "Problems in paradise," July 1994. (Bravo.)

Part 8: "406MHz-512MHz receivers," August 1994. (Bravo.)

Part 9: "150MHz receivers," September 1994. (Bravo.)

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Part 11: "Microprocessor board," November 1994. (Bravo.)

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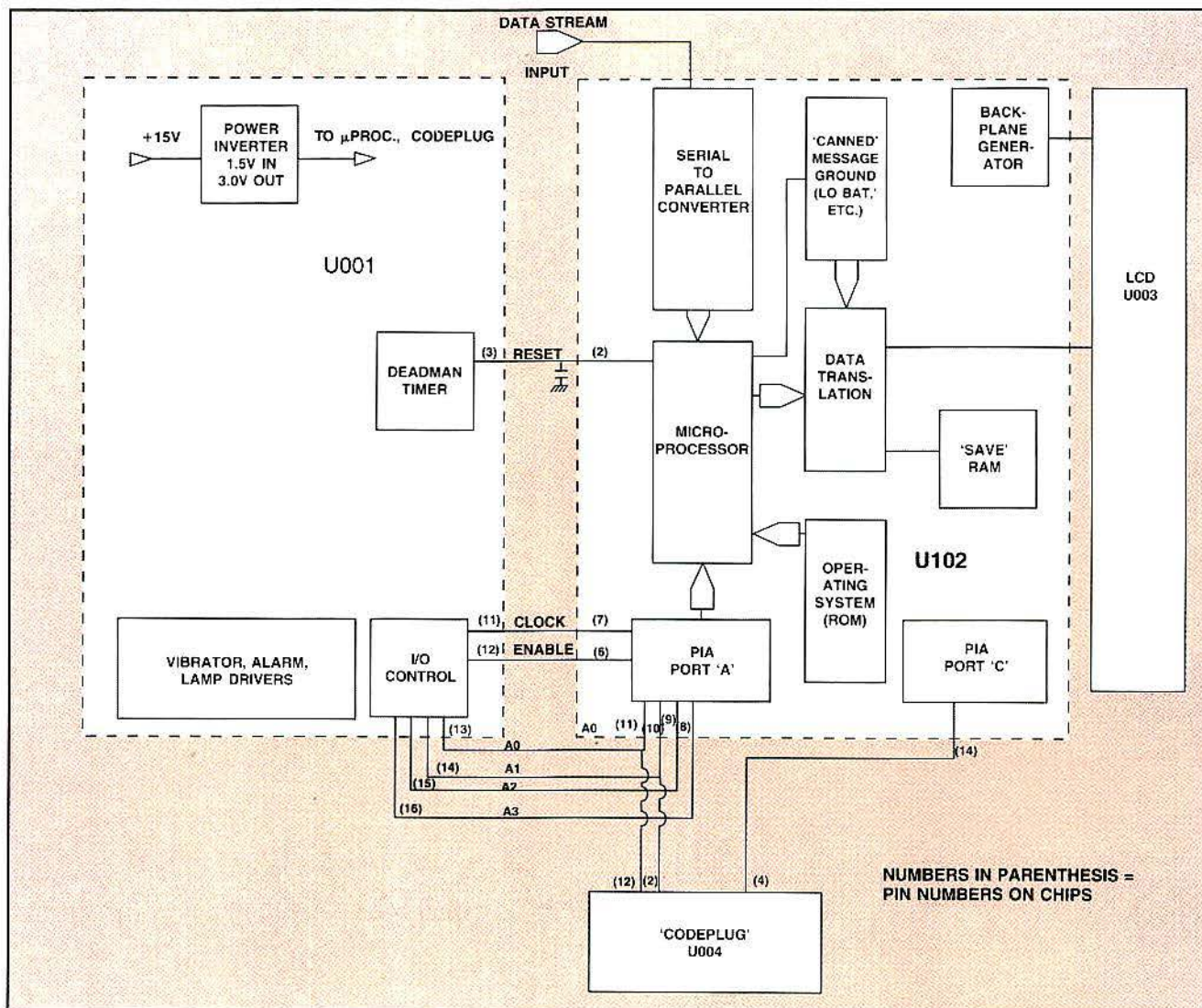


Figure 1. A block diagram of the Bravo decoder boards.

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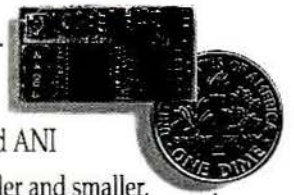
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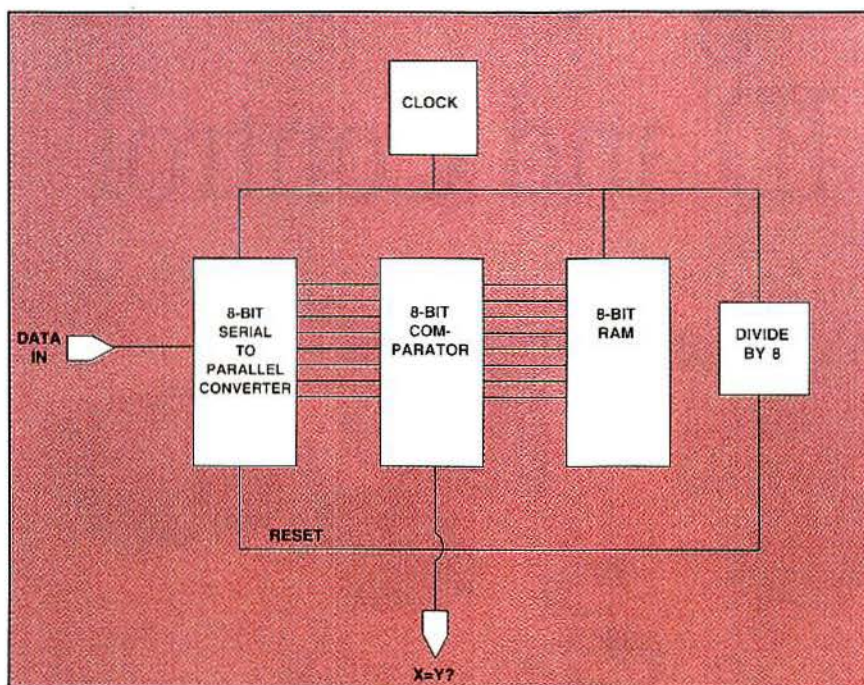


Figure 2. A block diagram of one method of comparing serial data. The Bravo uses a similar method of comparing 18 bits while looking for the capcode. It takes 32 bits to identify the proper pager, to determine the source and to perform parity checks at a rate of 512bps or 1,200bps for POCSAG. Assuming everything matches ( $X = Y$ ), the alarm sounds and the following 32 bits are decoded as a message to be seen on the liquid crystal display.

generates a *warm reset* of the operation outlined to this point.

A warm reset is performed without any external signaling and will be unnoticed by the user unless the pager fails to either beep or buzz when turned on.

Once data from the codeplug have been transferred to RAM, the Bravo begins to beep, flash, enable the display generator (BP1-BP4) and provide a broken horizontal bar to the display.

#### 'I'm looking for it!': format, results

Motorola has prominently displayed copyright notices throughout its literature to deter the unauthorized use of its techniques by competitors. We can, nevertheless, make an educated guess as to the coding structure, and here we concentrate on the POCSAG format.

The POCSAG format (regardless of speed) consists of a *preamble* and one or two *batches* of codewords. A 32-bit *frame sync* code precedes the *frame/codeword*. Each *batch* transmits signals to a maximum of eight pagers (16 for double-batch). Each *frame* contains a pager number and a message, with a total of eight *frames* (one for double-batch) being sent in a single *batch*. If the *batch* is occupied in only

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frames 1, 3 and 5, an idle codeword occupies frames 2, 4, 6, 7 and 8 (plus frames 9-16 for double-batch).

First, the *preamble* is 576 bits of alternating "101010...". The decoder in the Bravo uses this preamble to determine whether it is "hearing" POCSAG signals, and it determines synchronization with the transmitted signal. Note that if the *preamble* is transmitted at 1,200 baud, a 512-baud Bravo on the same frequency would

"hear" a continuous string of either 1s or 0s.

Similarly, a 512-baud signal would produce an alternating "11001100" in a 1,200-baud Bravo on the same frequency. Such invalid code response is what allows several formats to share a single frequency.

Next, the *batch*. Within each batch are eight (or 16) frames. Each frame is 64 bits long. The first 32 bits are the capcode programmed into the Bravo. The follow-

ing 32 bits contain the calling party's phone number or message.

*Frame synchronization* is a unique 32-bit code (011111001101001000001010110101000) that signals the beginning of each *batch*. The Bravo receiver board is activated each time this *frame sync* code is transmitted.

Within the Bravo codeplug, three bits have been programmed (by the capcode) to identify which *frame* in each *batch* is its own. (A double-batch pager would have four bits to identify which of 16 frames is its own). As the *batch* is sent, the Bravo turns on the receiver board only at the time its *frame* is being sent.

Up to this point, the information stored in RAM has been sitting there. Now, a comparison is made between the capcode information and the incoming data stream. (See Figure 2 on page 26.) If a match is found, the Bravo either beeps or vibrates. Further incoming data are then stored in RAM for display. This is the calling party's phone number or other information. Failing to match the capcode results in going back to looking for the *preamble*.

All this takes some split-second timing and a lot of coordination.

#### Meanwhile, back at the programmer...

From the preceding information, we can learn much about the programming of Bravo pagers.

When turned on, the Bravo Programmer asks, *GSC or POCSAG?* Your response to this question sets a bit in the Bravo that determines the *preamble* format. With POCSAG, the *preamble* consists of 576 alternating 1s and 0s. Golay has 14 alternating 1s and 0s sent at a rate of 600bps.

Next, the Bravo Programmer requests JRB/C or BAB. The JRB/C is used for two-board Bravos, one receiver and one decoder board. The BAB is used for single-board Bravo receivers not discussed in this series. JRB/C will place the POCSAG or Golay format in *normal*. BAB will place the format in *inverted*. These formats require the proper signal injection frequency in the receiver boards. "Normal" POCSAG or Golay usually is transmitted by paging systems. Most often, it is the receiver that is "inverted."

Selection of an *inverted* format also sets a bit to signal the need to logically AND the incoming data stream with a 1. This step produces a reversed image of the incoming signal (e.g., 10010 transmitted becomes 01101 received).

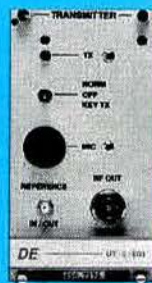
The capcode comes next. Hidden within the POCSAG capcode is the *frame* number it is assigned. Let's see where a capcode of 1034067 would be *framed*.

Divide 1034067 by 8. The quotient

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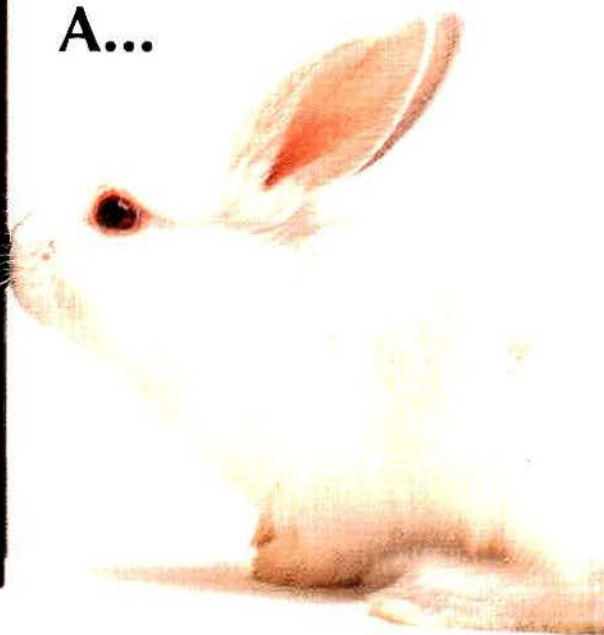
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equals 129258.375. Multiply the decimal portion of the answer by 8. The product of  $0.375 \times 8 = 3$ . Recall that this is actually the 4th frame because the frames start at true 0 and count to either 7 or 15. We just don't start counting at zero!

### The heart-beat: synchronization

Acquiring and synchronizing with an incoming data stream takes some sophistication, but it is nicely done in the Bravo pagers by generating impulses at a regular rate of speed.

At 512bps, there are 576 bits (preamble) + 32 bits (frame sync) +  $(8 \times 64 = 512 \text{ bits})$  (eight frames), for a total of 1,120 bits per message. Because these 1,120 bits take 2.187472 seconds for transmission, divide 2.187472 by 1,120 to determine the duration of each bit;  $2.187472 \div 1,120 = 0.0019531$  seconds or 1.9531 milliseconds.

By reciprocation, we find that the clock is operating at  $1/0.0019531 = 512\text{Hz}$ . This value is easily achieved by dividing the 1.048576MHz time-base crystal frequency by 2,048 (a 10-bit shift).

Similarly, dividing the 2.457600MHz crystal frequency (used at 1,200bps) by 2,048 results in a clock frequency of 1,200Hz. By reciprocation,  $1/1,200 = 833.3$  microseconds, the duration of each bit in 0.933296 seconds (the message time at 1,200bps).

Somewhere in this chip is a stage with the single function of counting these impulses and signaling when the count reaches 32. For want of a better term, call 32 impulses a *click*.

Everything in the POCSAG signal format is divisible by a number of clicks. There are 18 clicks in the *preamble* ( $576/32 = 18$ ); there is one click in the *frame sync* and two clicks per *frame*.

For the duration of each click, a comparison is made. Does the information in the data stream during one click match the *preamble* (101010...)? If so, the receiver is turned on to receive the *frame sync*. If the click window matches the first half of a *frame* (the capcode), then the alert is signaled while the receiver stays on to get the next click of information (the calling

party's number). These go into RAM.

Failing to match the capcode in its assigned *frame*, the Bravo starts looking for the 576-bit *preamble* and the 32-bit *frame sync code*.

Lacking a *preamble*, the Bravo drops into *POCSAG battery-saver mode*. The receiver is turned on for 217 milliseconds out of every 1.047 seconds (for POCSAG 512) and 93 milliseconds out of every 1.047 seconds (for POCSAG 1,200).

### 'Look what I found!': memory display

Once the Bravo "sounds off," it is free to display the converted data on the liquid crystal display (LCD).

Recalling the data stream "snapshot" from RAM (by depressing the *gray read* button at pin 9 of U001) involves two operations. The first depression of the *read* button silences the tone (if it is on). The second depression causes the microprocessor to transfer RAM contents into a decoder, and then to the display.

U102 contains 12 8-bit registers.

These may hold as many as three 32-bit *words* — incoming phone numbers — and are enabled by use of the *protect* switch at pin 45 of U102. As long as power is available from pin 4 U001, these numbers remain in *memory*.

Electronically, the display section consists of the LCD driver, the LCD and a light switch. Another portion of the microprocessor is used to drive the multiplexed display and to provide backplane ac signals.

There is still more: Several *canned* messages are available when needed, as is a 3.2kHz audio generator to feed the *beep* speaker.

In all, there is a lot of technology to be found in the Bravo pager.

### Acknowledgement

I would like to thank the management and staff of JJ Sounds & Communications, South Houston, TX, for their help with this project. Tel: 713-944-1813.





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By Dean Cubley

RF power amplifiers capable of extended operation or even continuous-duty

Cubley is vice president and chief technical officer with Eagle Telecom International, Houston. Eagle manufactures the type of amplifier described in this article.

service for radiopaging, two-way radio repeater and point-to-point link service face thermal stresses that can lead to amplifier failure. Constructing amplifiers for use in conditions with wide temperature fluctuations challenges engineers to configure circuits and to select components that will operate reliably.

## Previous designs

Many older amplifier designs—including

some that are only three to seven years old—suffer from several common failure modes that may involve a power combiner circuit, the circuit board material or transistor selection. Some amplifier designs, for example, use power transistors incapable of delivering the amplifier's specified power output. These and other amplifiers also may be deficient in heat dissipation because of improper thermal design. Many power amplifiers have well-defined

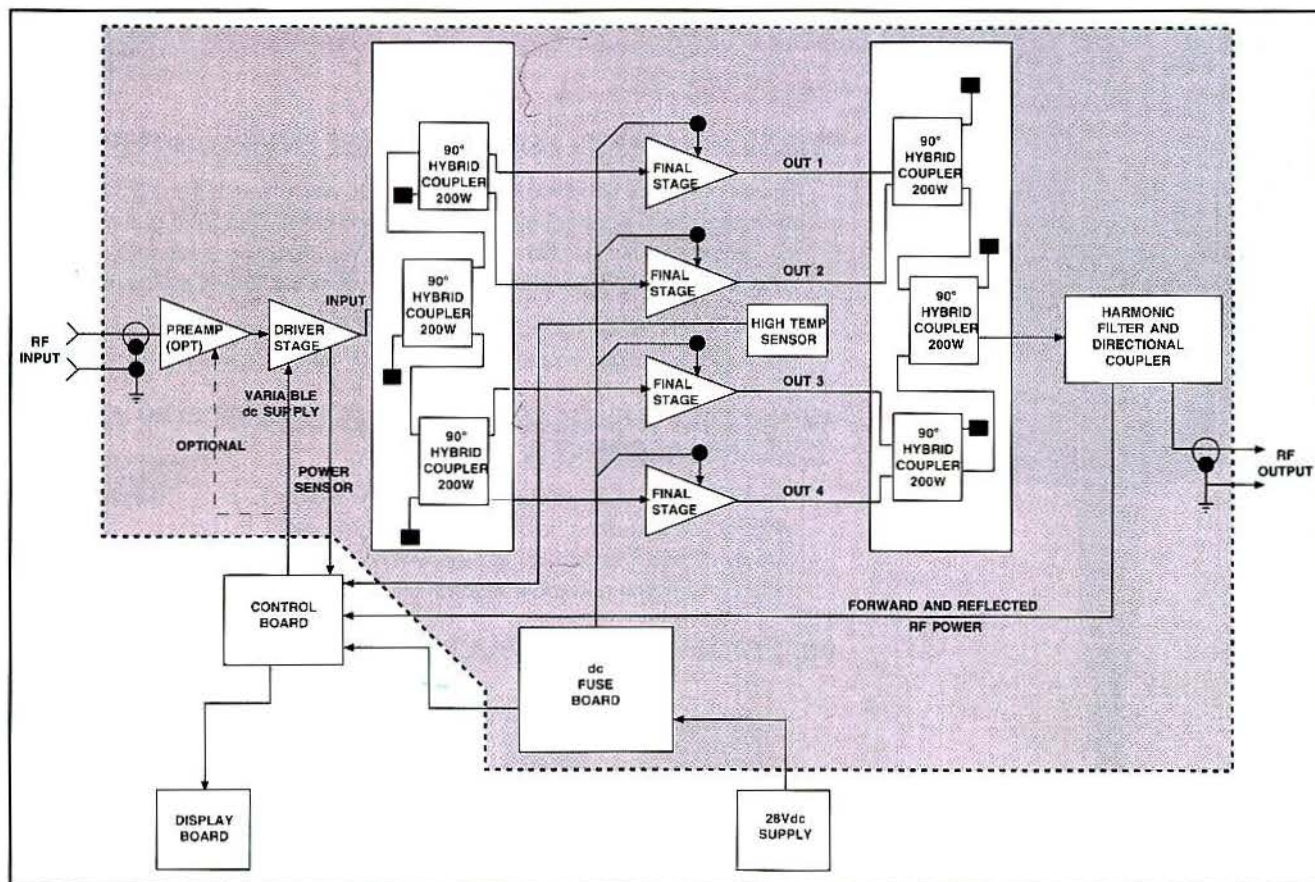


Figure 1. The new power amplifier design reduces the number of combining points to achieve the highest possible power output with the least number of components, all while derating the components to the maxi-

um degree feasible for the highest reliability. New circuit board materials and thermal design techniques help to eliminate amplifier failure under heavy use in extreme environmental conditions.



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lifetimes because of the use of low-cost circuit board materials and other associated materials. Although these designs were the best that could be made at the time, they are not up to current technology.

#### New designs

Amplifiers designed to overcome the previous problems include an exceptionally stable, high-performance thermal design, even to the extent of over-designing

the thermal capabilities. The thermal design incorporates materials that were previously used only in military and aerospace programs and never before for commercial base station amplifiers.

These materials, which are known as *ceramic thermoset polymer high dielectric composites*, were previously too expensive to use in land mobile applications. Many aerospace industry suppliers are now taking a second look at the commercial

industry and bringing their prices down because of the dwindling demand from aerospace equipment manufacturers.

□ *Circuit board materials* — The new materials have extremely good thermal and dielectric performance that is consistent over a wide range of conditions. For example, the circuit board materials are made with highly stable dielectric characteristics originally intended for use in earth-orbiting satellites. With dielectric constants as high as 10, these circuit boards have extremely stable thermal properties.

Some amplifier failures can be traced to non-compatible expansion and contraction by connected components under temperature extremes. This incompatibility in-

*The circuit board materials are made with highly stable dielectric characteristics originally intended for use in earth-orbiting satellites.*

creases the potential for broken joints. When that one problem is eliminated, as much as 50% to 70% of the problems with a high-power amplifier are eliminated.

When taking circuit board dielectric and thermal properties into consideration, it is most common to evaluate the *x* and *y* axis (length and width) variables, but they are not the most important. The *z*-axis (thickness) variable is the most important. When the thickness of the board material varies, the amplifier may have an impedance mismatch. The *z*-axis has largely been overlooked in the past by manufacturers because materials with stable *z*-axis characteristics have not been available.

□ *Transistors* — New components that are available at higher power ratings help to make the amplifier design more reliable. The biggest problem areas are where lower-power stages are combined into a high-power output. The new design uses the latest high-power transistors to reduce the number of combining points. The goal is to reduce the number of combining points to achieve the highest possible power output with the least number of components, all while derating the components to the maximum degree feasible for the highest reliability.



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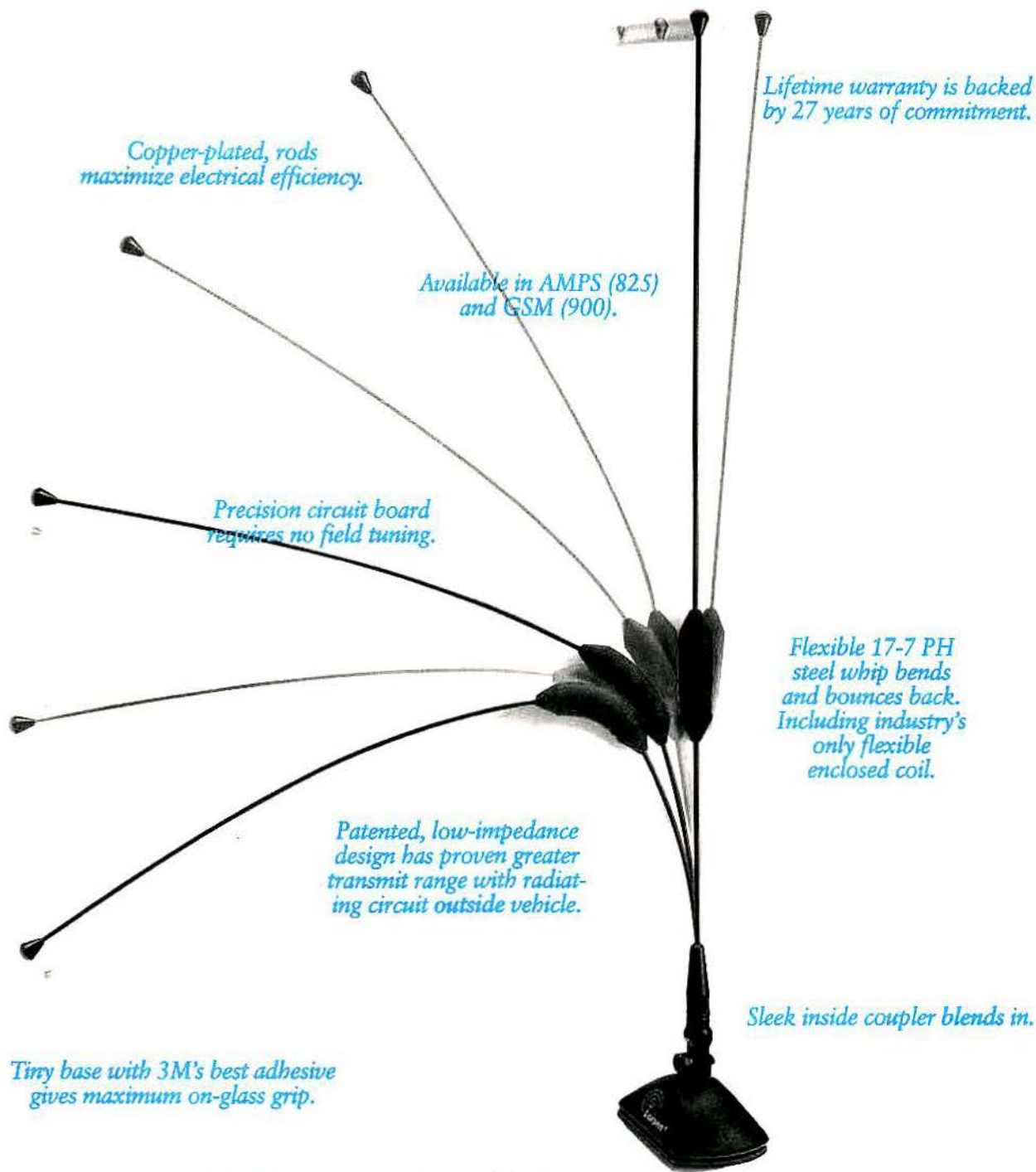
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# Smart installations

*Intelligence and communication make installation guidelines fit customer expectations. Use waiver forms as a last resort for functional and safety discrepancies, and offer portable and transportable phones as alternatives.*

By David J. Kushman

Your own intelligence is the best tool for cellular telephone installations and repairs. Communication skills are the most important part of customer service.

Maybe you have heard the saying, "The customer is always right." You also have seen situations where the customer is dead wrong. The correct phrase should be, "Customer satisfaction is always right."

A cellular technician or installer knows certain guidelines for properly installing a cellular mobile telephone: handset and transceiver location, antenna placement and cabling considerations, for example. Often, how these installation steps are handled is dictated by both the type of phone and the type of vehicle involved.

## Fitting guidelines together

A customer also has guidelines as to how the installation should perform and look. Even though many installations are similar, many more are unique—because customers are unique.

A technician must fit his guidelines into the customer's guidelines. Good communication and a proper attitude help, so keep an open mind, a sharp eye for detail and a positive attitude.

Suppose you are installing an on-glass antenna and you decide that, because of the type of vehicle and the length of the antenna cable, there are two advantageous antenna locations. You offer these options to the customer, who makes a choice. Perhaps one location is difficult to reach to remove the antenna at a car wash, so the customer chooses the second. You have just fit your guidelines to the customer's guidelines. Thinking, and then communicating, is the key.

## Discrepancies

Only when the customer's guidelines fall beyond the technical guidelines does a conflict occur. For example, imagine explaining possible handset mounting options (your guidelines), and the customer

explains that he would like the handset mounted on the center console, perhaps simply because of personal preference (the customer's guidelines). You notice that mounting the handset there would obstruct the stick shift. This problem is a *functional discrepancy*, which describes any customer guideline that interferes with the function of a vehicle or the cellular phone.

A second type of discrepancy is a *safety discrepancy*. Using the previous situation, let's say that the customer's choice of handset position is the driver's side of the center console by the driver's right leg. In this position, the handset could fall off of the cradle and interfere with the operation of the brake or accelerator pedals, or the

that your guidelines are intelligent and that you care about the quality of your work.

The third thing to do is to present another option, if you can re-evaluate the situation and find an additional solution.

Usually, a customer is quite receptive if you take the time to explain carefully. Make sure that you have examined the vehicle and the possibilities prior to the installation. Have your guidelines defined first, and then try to integrate them with the customer's guidelines.

If several options have been discussed, find out whether another technician can help. Inviting a third party into the picture may reveal something you missed. A third party also can be helpful as a witness to your proper handling of the customer.

## Discrepancies

☐ **Functional discrepancies interfere with the operation of vehicle or telephone features because of the telephone's mounting position.**

☐ **Safety discrepancies have the potential to interfere with the operation of vehicle controls, such as the accelerator and brake pedals. For example, the customer's preferred telephone mounting location may allow the handset or cord to become entangled with the pedals too easily during normal use.**

**Discrepancies can be resolved with communication that points the way to a better telephone mounting location, with a waiver form or with alternative telephone choices.**

coiled cord could cause a vehicle control problem. This mounting option is excluded from your guidelines.


The first thing to do if there is a discrepancy between your guidelines and the customer's is to tell the customer why the discrepancy is a problem, or better yet, demonstrate why. Be polite and professional, and use simple terminology as much as possible. Do not argue.

The second thing to do is explain your guidelines. Let the customer know why you selected them. This discussion shows

## Waiver

If the customer insists on having his own way in spite of a functional or safety discrepancy, you may have to take another course of action. Do not abandon your guidelines, especially in the case of a safety discrepancy. Ask the customer to sign a waiver form releasing you from responsibility for problems that the installation may cause. You can design a printed form for a non-standard installation, or you can describe the problem on any multipart form. State the situation clearly, and have the customer sign and date the form. Both you and the customer should retain a copy. This documentation will help you if the customer later suffers a loss and makes a claim based on the installation.

If a customer refuses to sign a waiver, then before declining the job, offer a portable or transportable phone as an option. I have sold phones this way, and the customers have always appreciated my honesty and helpfulness.

The best thing to do is to use your head and keep your wits about you, using communication and common sense. This approach is the difference between a smart installer and the average guy. 

Kushman is a technician in Parma, OH.

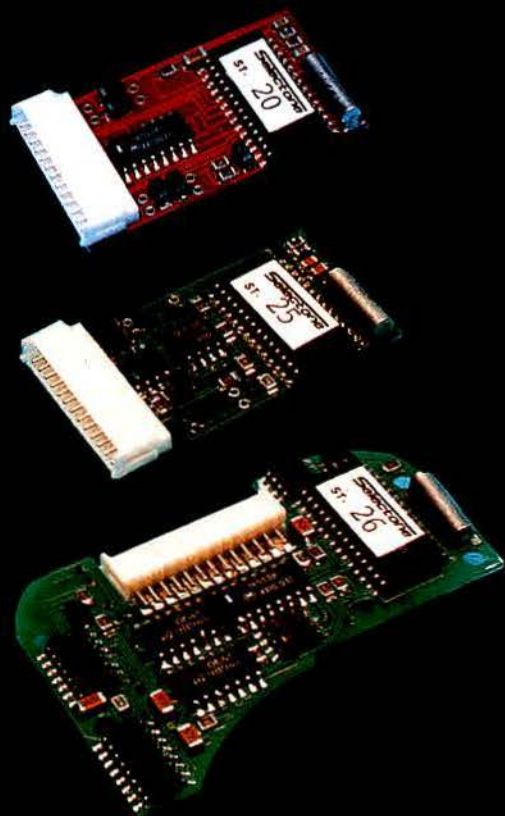


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# Mechanics and money: The rewrite of Part 22

*The FCC rewrites and revises rules for land mobile radio system operation, expanding the use of auctions to assign licenses. Comparative hearings are re-introduced in circumstances where an application involves a system modification.*

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by Robert H. Schwaninger Jr.

On Sept. 9, 1994, the Federal Communications Commission continued its mission toward rewrite and revision of its rules regarding operation of land mobile radio systems by publishing its Report and Order rewriting Part 22 of its rules. The Rewrite is a reaction to greater consolidation within the market, a reflection of the FCC's new auction authority and a study in hesitation.

Part 22 includes the rules governing the use of traditional radio common carrier (RCC) channels, two-way and paging, and cellular systems. The Rewrite dealt substantively with each, but left open many questions for which numerous observers had sought answers.

Readers with substantial stakes in RCC or cellular systems would do well to obtain a copy of the Rewrite and study it. No one better competes before the FCC than an operator who is equipped with comprehensive knowledge of the rules. But if you have not done your homework yet, here are some "Cliff Notes" on the subject (which I do not recommend you exclusively rely on for your final exam).

## New cutoff rule

The Rewrite reduced the cutoff date for filing competing applications from 60 days to 30 days. After an application has appeared on public notice for 30 days, competing applications will not be accepted.

For operators who have been the victims of strike applications, this change is welcome. The reduction will hamper the filing of competing applications by per-

sons who use the application process for improper competitive purposes. It will also (one hopes) speed up the processing of applications.

If competing applications are filed, the FCC will haul out the block and gavel and begin the auction. The operator who wants the frequency or service area the most had better be prepared to bid highest, because the FCC litmus test of intent to serve the

---

*The operator who wants  
the frequency or service  
area the most had  
better be prepared to bid  
highest, because the  
FCC litmus test of intent  
to serve the public will  
now be a test of bank  
accounts.*

---

public will now be a test of bank accounts.

The exception to the auction rule will be for applications that request minor modification of an existing system. Such applications will be granted, and competing applicants need not apply—even applicants with really deep pockets.

Within its Rewrite, the FCC expressed some uncertainty as to how it would differentiate between an "initial" application, subject to auction, and one that is for a minor modification and, therefore, exempt from the auction rules. It appears that the FCC is leaning toward drawing the line narrowly, with the preferred method of deciding being auction.

The logical interpretation of the FCC's direction is that all but extremely minor modifications will result in an auction, if a competing application is filed. On one hand, competitors will have less time in meeting the cut-off date. On the other hand, when competition for frequencies exists, money will be the deciding factor.

## The 'two-fer'

If you have grown tired of ginning up another channel occupancy report, complete with bouncing busy hours and dripping with erlangs, the FCC will save you the trouble in the future. Applicants for two-way frequencies may apply for as many as two additional frequencies without having to demonstrate loading or usage.

Instead, the FCC will concentrate on construction and offering of service to the public. The FCC will require that, prior to applying for additional frequencies, an operator must construct and offer service to the public. The public offering will include the provision of service to at least two customers who have no affiliation, by money, stock, employment, marriage or birth, to the operator.

You should note that the "two-fer" only applies to persons who promise to provide two-way service. It does not apply to operators who employ the channels for paging service. Given this discrimination in obtaining channels, it could be that the FCC is guaranteeing that Improved Mobile Telephone Service (IMTS) or 450MHz trunking using RCC frequencies will not face immediate extinction.

If one adds a little dispatch authority to the mix, one might believe that the FCC has created a landing spot for former SMR operators who have sold out to Nextel. With pre-emption of most state regulation regarding rates and entry already a reality, the path appears to be open.

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Schwaninger, MRT's regulatory consultant, is a partner in the law firm of Brown and Schwaninger, Washington, DC. He is a member of the Radio Club of America.



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Radio Service (BETRS) operators do not have to worry about the FCC's two-to-a-customer rule. It does not apply to BETRS applicants who often apply for as many as four channels at a time to serve rural areas. The FCC will allow BETRS operators to continue to request more than two frequencies at a time, and has decided to handle each request on a case-by-case basis.

Two other decisions contained in the Rewrite might affect future BETRS applica-

tions. The FCC decided to limit the effective radiated power of BETRS facilities to 24W at a standard antenna height of 152.4 meters. The FCC's decision reflects its opinion that BETRS operation is essentially low-powered and limited in geographic coverage.

The FCC also decided to keep its options open regarding use of the 800MHz band for future BETRS applications. It appears that the FCC is committed to pro-

viding rural telephone service, either using the existing allocation or using future allocations, as conditions demand. Therefore, it is reserving to itself all options for meeting its goal.

In a related decision, the FCC admitted that its existing rules that require all RCC operators to provide Rural Radio Service on demand may not be logically applied to paging operators. The reality of demanding two-way service from an operator who employs a frequency only for paging appeared somewhat onerous. The FCC removed that requirement.

#### Order from chaos

For years, the FCC's application processing and procedures for granting authorization for 931MHz paging has been... well, a mess. Within the Rewrite, the FCC is trying to clean up this portion of its house by adopting new procedures to process the hundreds of applications that are lying about in the "pending" bin, while creating additional rules to avoid future problems.

The mess was caused by the FCC denying 931MHz paging applicants the right to select a proposed frequency. Applicants could make suggestions, but the suggestions were not binding on the FCC or the applicant. As long as sufficient spectrum existed, this system presented few problems.

As spectrum became scarce, the problems multiplied. For example, the FCC has on file for Los Angeles at least a dozen applications for new stations, modifications, fill-in transmitters, etc., all seeking, in accord with the existing rules, unspecified frequencies. This creates a huge mutually exclusive (MX) situation, because all of the remaining 931MHz spectrum is up for grabs among the applicants.

Some of the Los Angeles applicants are attempting to modify authorizations to assist in expanding existing systems; therefore, they are only interested in specific frequencies. However, under the existing rules, their applications are treated as though those applicants have no interest in the exact channel that might be granted.

To resolve this logjam, the FCC will ask that all persons with pending applications for 931MHz channels pick a frequency. The FCC will then sort through the selections for MX situations, employing auctions to select among competing applications. The Rewrite is silent on the question of whether an applicant that already chose a frequency in its original application may be forced into an MX situation by another applicant's long-delayed frequency selection. I suspect the FCC will allow this to happen.

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**ASTRON** SL-11A

32A

33

33A

35A

Fuji PDP

33

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34

5

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## The Rewrite's odds and ends:

- ❑ allow multi-frequency transmitters.
- ❑ allow the use of RCC transmitters for non-RCC operations.
- ❑ allow power as high as 3,500W for 931MHz paging transmitters.
- ❑ prohibit duplication of cellular units' electronic serial numbers.
- ❑ prohibit sharing of transmitters by operators.
- ❑ defer consideration of finder's preference procedures.
- ❑ reject conditional licensing upon application.
- ❑ defer decision on market-area licensing for non-cellular operations.
- ❑ eliminate reinstatement of expired construction permits.
- ❑ maintain the use of NAD 27 geographic coordinates.
- ❑ preview the use of a new FCC Form 600.
- ❑ preview the use of electronic filing of applications.
- ❑ adopt a mechanical engineering method, ending the use of Carey.
- ❑ ratify the FCC's files as the "official record."

Most surprising is the FCC's decision to employ comparative hearings when future MX situations arise from the filing of competing modification applications or when an initial application is mutually exclusive with a modification application. The Rewrite is somewhat thin on what criteria

would be employed to decide a winner at hearing, but the fact that the FCC is willing to employ comparative hearings for any purpose in the grant of a land mobile license is news. The FCC has avoided using comparative hearings for such purposes for years.

Finally, the Rewrite states that if an application is for modification, the FCC will grant it unless a competing application is filed on the same day. Remember, however, that the FCC's new definition of "modification" is highly limited.

## Moving up construction

The Rewrite now codifies as rules the same changes affecting the schedule for constructing radio facilities that already had been made through amendment of the Communications Act. Applicants can begin construction of common carrier facilities prior to grant, a former taboo.

The new rules state that if no protest is filed (and a few additional, rare caveats), then an applicant may commence construction upon the thirty-fifth day beyond the date the application went on public notice. Given the FCC's new rules about eligibility arising out of construction and operation, this new section will give amassers of spectrum a jump in obtaining channels.

And if you are wondering where to post your construction permit at the site, the new rules no longer state that the authorization must be at the transmitter. Instead,

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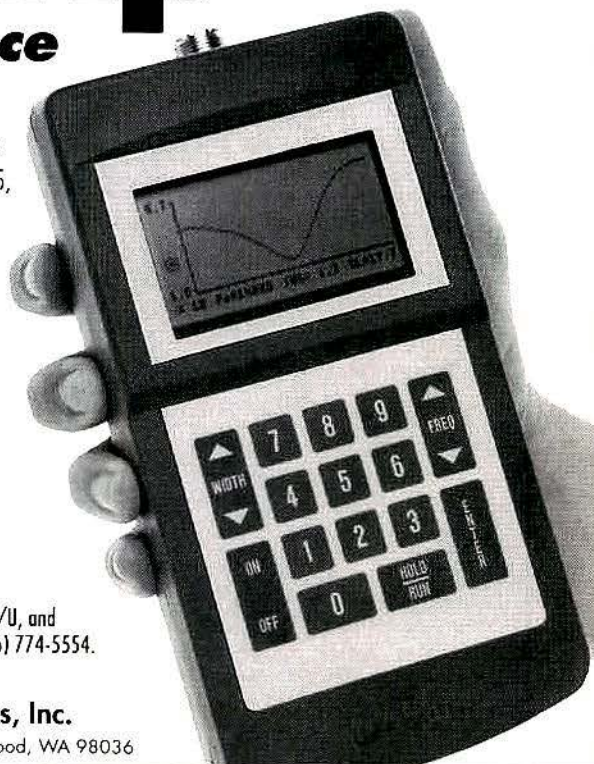
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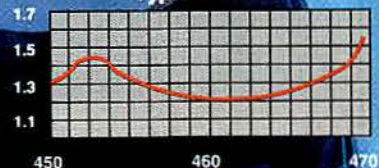


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the rules state that the authorization must be "on or near" each base or fixed station transmitter. Presumably, the authorization can be placed in a common book within an enclosure and need not be tacked up on the front of each transmitter.

#### No creeps allowed

For years, operators have employed the FCC rules regarding fill-in transmitters to gain authority for new facilities which create creeping contours, expanding an operator's service area. By filing multiple fill-ins, an operator could, beyond the glare of the public notice provisions, steadily increase his protected service contours. The new rules will put a stop to creeping contours by placing all increases in service contours on public notice, thereby alerting competitors to an operator's intention.

Truly "minor" modifications will not require that operators file notifications, via Form 489s, with the FCC. Although such changes will not require notification, one may wish to go ahead and file. Failure to file notifications will mean that the modifications will not be entitled to protection in close cases involving dueling engineering studies.

Speaking of FCC Form 489s, the FCC has relaxed its requirement regarding when the form must be filed. The new rules state that an operator must place notification of construction on file with the FCC within

*The Rewrite does not address the issue of "holes" in cellular coverage and speaks as though all cellular systems are contiguous operations.*

15 days after operations begin. Formerly, any operation prior to filing the form might cause the operator to be slapped with as much as \$30,000 in fines.

Some of the comments were directed at the FCC's requirements regarding report-

ing changes in cellular systems service areas. The FCC will require specific information regarding the construction or removal of external cell sites that alter cellular service areas, but will be lax on reporting of information regarding internal cells that will have no effect on the operator's actual service area. Even greater specificity in reporting will be required when a revised contour will extend into an adjacent market.

The Rewrite does not address the issue of "holes" in cellular coverage and speaks as though all cellular systems are contiguous operations. One must wonder whether this is, in fact, true, and whether additional reporting requirements would answer this question for potential applicants.

#### Stepping back

There is always a temptation to concentrate on the minutia when the FCC rewrites a portion of its rules. A word here and a line there can create a loophole through which lawyers consider what some of the effects will be on future licensing.

Auction is an expensive method for obtaining channels. It also creates obvious advantages for the deepest pockets. To



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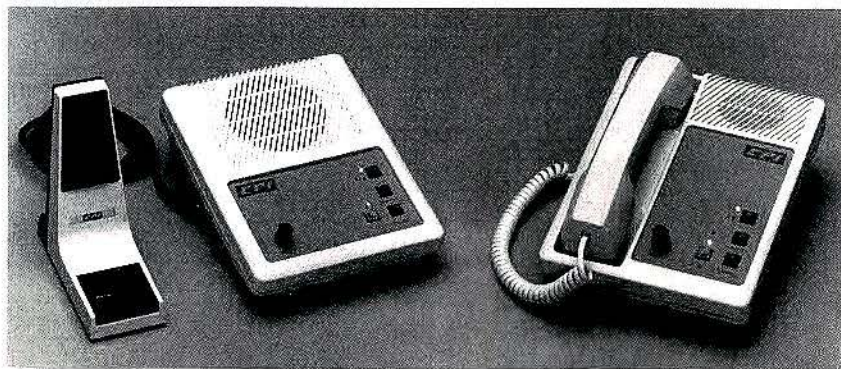
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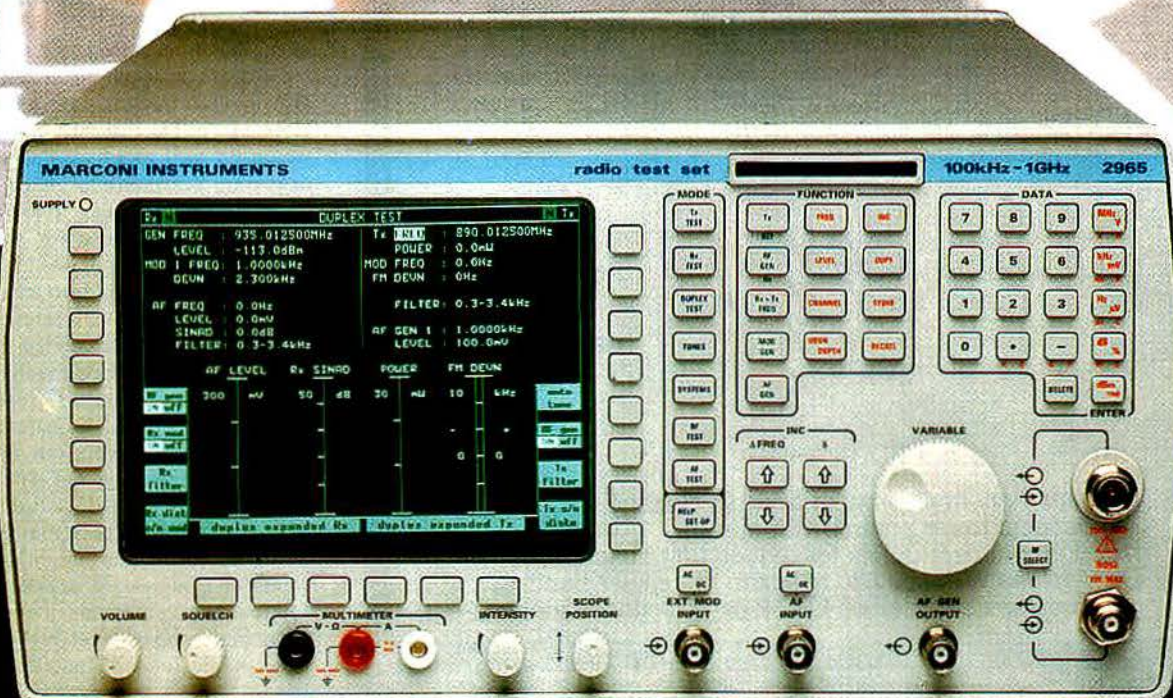
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avoid the costs associated with auctions, many applicants will probably resort to litigation, trying to get a competitor's applications tossed out for uncrossed "t"s and undotted "i"s. Logically, some will be convinced that paying the lawyer is cheaper than paying the auctioneer.

The industry and the FCC can expect greater amounts of litigation and the acrimony that such activity sometimes causes. This possible result of the new rules is a

bit disturbing, even for lawyers. The reason is that the FCC's track record in resolving litigation is abysmal. Cases have been known to languish for years before the FCC, simply awaiting a decision on the merits.

To avoid having to make such decisions, one attorney at the Mobile Services Division has stated, "if they don't settle the matter, the case will just sit on my desk and rot for years." Although the FCC's

encouragement of settlements might be seen as beneficial, in those instances where settlement was not possible, the FCC has rarely moved ahead promptly.

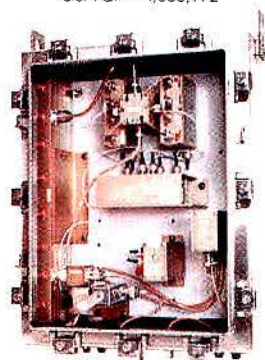
Operators can, therefore, expect greater amounts of litigation, because the use of auctions raises the stakes. The use of litigation might be a successful strategy for delaying a competitor's grant, but probably will not be effective in obtaining a grant, because the likelihood of getting a final decision from the FCC within a year is slim.

And while operators are fighting before the FCC, they are likely to be cutting deals in boardrooms. The FCC will not hold an auction if the parties have reached settle-

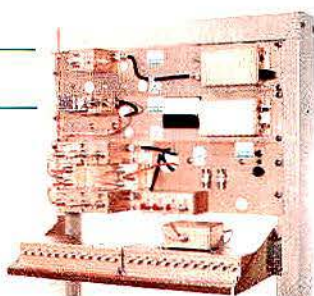
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many applicants will  
probably resort to  
litigation, trying to get a  
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ment; therefore, there is a real incentive to cut a deal and avoid auction. These deals also involve risks arising out of possible violations of the anti-trust laws. Operators would do well to assure that their settlements are not going to create fodder for others to complain that a combination or conspiracy was created for anti-competitive purposes.

The new laws go into effect Jan. 1, 1995. With the new rules comes a new playing field that is expected to make the FCC's job a bit more mechanical. The reality may be quite different and may increase the level of litigation. One area that has received little attention is the question of minority and small business involvement in the process. At some juncture, one might expect that Micro-mini Communications Inc. might just ask the courts or Congress to decide whether an auction between it and a regional Bell operating company will really provide a valid public interest analysis.



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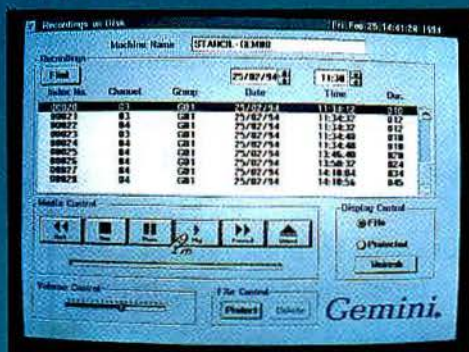


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## Technically speaking

(continued from page 8)

handle this measurement easily, even reading the voltage as low as  $-50\text{dBm}$  ( $2.45\text{mV}$ ).

### Frequency response

A typical 3002 line may exhibit an attenuation of  $-2\text{dB}$  to  $+8\text{dB}$  over the frequency range of  $500\text{Hz}$  to  $2,500\text{Hz}$  as referenced to the attenuation at  $1,000\text{Hz}$ . This attenuation range means that if the line loss is already  $16\text{dB}$  at  $1,000\text{Hz}$ , then the attenuation above or below  $1,000\text{Hz}$  may be as little as  $14\text{dB}$  ( $16 - 2$ ) or as much as  $24\text{dB}$  ( $16 + 8$ ). This variation can be critical when low-level control tones are involved.

For example, the function tone normally is transmitted about  $10\text{dB}$  below the level of the  $2,175\text{Hz}$  high-level guard tone, and the  $2,175\text{Hz}$  low-level guard tone is transmitted about  $30\text{dB}$  below the level of the high-level guard tone. If the high-level guard tone is transmitted at a level of  $0\text{dBm}$ , then the low-level guard tone is transmitted at a level of  $-30\text{dBm}$ . At the extreme limits of the allowable line loss, the  $2,175\text{Hz}$  low-level guard tone could be attenuated by as much as  $24\text{dB}$ . This at-

tenuation would bring the low-level guard tone down to  $-54\text{dBm}$  at the end of the line. If the termination equipment requires a low-level guard tone at  $-50\text{dBm}$ , then a  $-54\text{dBm}$  tone is  $4\text{dB}$  short of the system design goal. In this case there are only two choices: (1) Improve the line response (telco) or (2) increase the level of the control tones being applied to the line.

---

*All control tone frequencies should be included in the response check. Strange things can occur on telephone lines!*

---

Increasing the high-level guard tone to  $+10\text{dBm}$  would place the low-level guard tone at  $-44\text{dBm}$  (at the far end of the line). This level would provide about a  $6\text{dB}$  reserve, assuming the system design requires a  $-50\text{dBm}$  low-level guard tone. Because the duration of the high-level guard tone is

only about  $150\text{ms}$  or less, the tone may be transmitted at a higher level than would be permitted for a constant or long-duration tone.

Generally, telco uses a three-point frequency response test. The reference is  $1,004\text{Hz}$  (not  $1,000\text{Hz}$ ) with the low-end test point at  $404\text{Hz}$  and the high-end test point at  $2,804\text{Hz}$ . Typical results of a three-point response test are shown in Figure 4 on page 52. The slope is  $10\text{dB}$  at  $2,800\text{Hz}$  and  $8\text{dB}$  at  $400\text{Hz}$ . The results of the three-point response test do not tell the whole story, but it is good to know this information to communicate more intelligently with telco employees.

A more thorough frequency-response test should include an audio sweep from at least  $500\text{Hz}$  to  $2,500\text{Hz}$ . This test can be done at incremental values of about  $100\text{Hz}$ . All control tone frequencies should be included in the response check. Strange things can occur on telephone lines! A severe notch at one of the control frequencies can render a system useless.

These tests usually require two technicians, one on each end of the line. (Take my word—you do not want to perform these tests with the help of a lay person who does not understand how to operate

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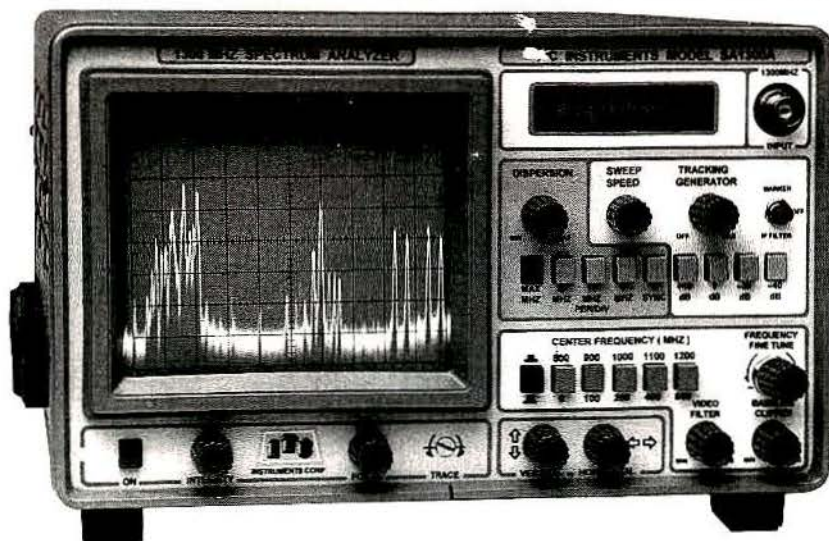
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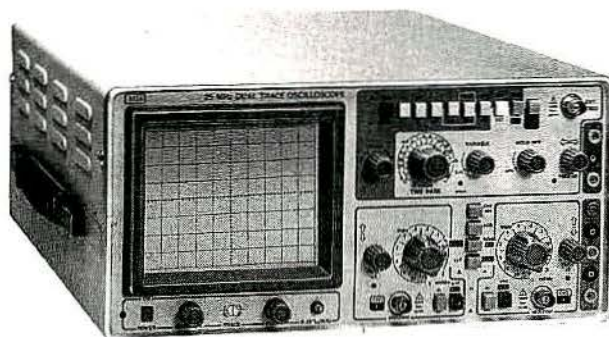
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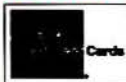
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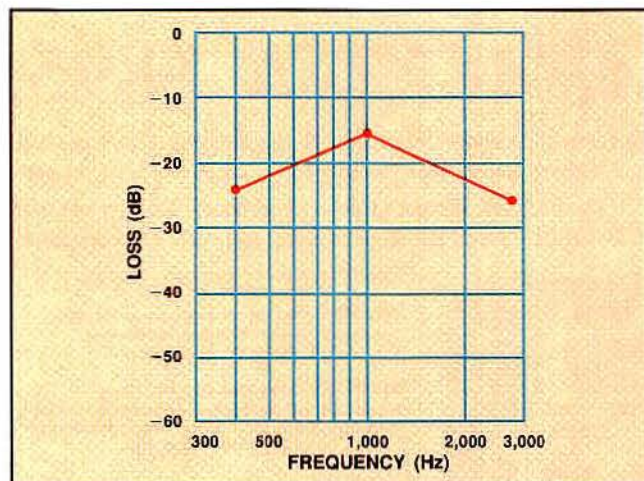


Figure 4. This graph shows typical results of a three-point frequency-response test. The slope at 2,800Hz is about 10dB, and the slope at 400Hz is about 8dB.

the instruments!) Communication between the two technicians is essential to coordinate the test procedure.

Generally, the technician at the sending end makes sure that the signal level at the input to the line is kept at a constant level, 0dBm or some other fixed reference. Then, as the frequency is varied, he keeps the technician on the other end informed of

the current frequency so that when dips or notches occur, the frequency can be noted. The results can be plotted on graph paper such as was used to graph Figure 4.

Special equipment such as a programmable function generator and a transmission impairment measuring set (TIMS) such as the one shown in Photo 1 on page 54 are especially helpful. For example, the

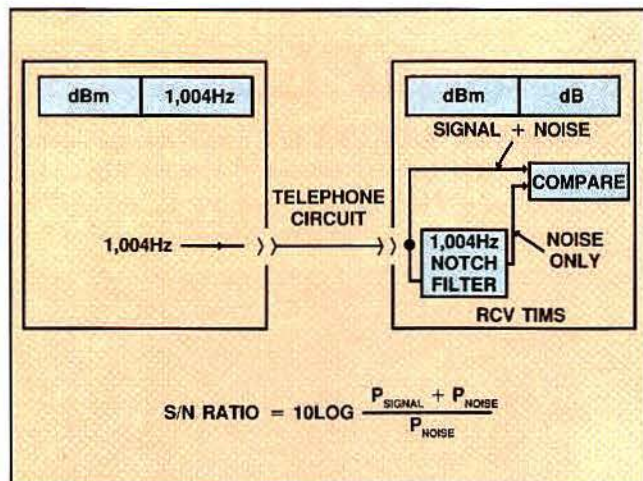


Figure 5. This block diagram illustrates how the Hewlett Packard 4935A TIMS determines the signal-to-noise ratio on the line. Courtesy Hewlett Packard.

programmable function generator can be programmed to perform an audio sweep from 500Hz to 2,500Hz over 90 seconds. The TIMS is connected to the opposite end of the line. The signal level and frequency are displayed on a digital readout on the TIMS. A built-in speaker allows the technician to hear what is being measured.

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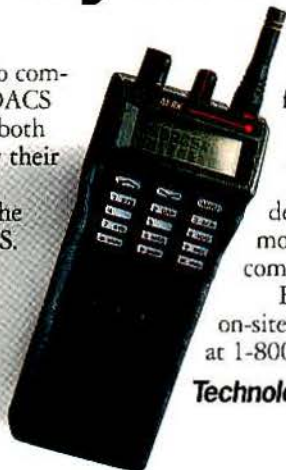
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## Technically speaking

used, the frequency-response and line-loss tests should be performed in both directions. The loss and response can be different in opposite directions.

### Bandwidth

Generally, the bandwidth of the line is considered to be the difference between the high- and low-frequency points at which the attenuation is 10dB greater than the attenuation at 1,000Hz. This difference

can be determined from the response-curve plot obtained with the test procedure described previously.

### Signal-to-noise ratio

Figure 5 on page 52 shows how the Hewlett Packard model 4935A TMS determines the signal-to-noise (S/N) ratio. Actually, it is signal-plus-noise-to-noise (S+N/N) ratio, but if the noise level is low in comparison to the signal, the S/N ratio



Photo 1. The Hewlett Packard model 4935A transmission impairment measuring set (TIMS) can be used to perform many different telephone line tests, including S/N ratio, noise, frequency, dBm level and more. *Courtesy Hewlett Packard.*

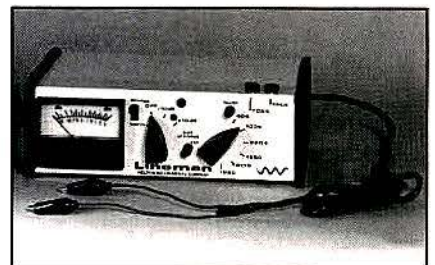


Photo 2. The Model LM-106 Lineman from Helper Instruments is capable of generating standard telco tones and standard tone-control tones. It is portable and easy to use. *Courtesy Helper Instruments.*



Photo 3. The Model 4 Loop Tester from Triplet can be used to generate and measure tone signals. It has a built-in C-message filter. *Courtesy Triplet.*

is roughly equal to the S+N/N ratio. Notice that this is the same principle used in the SINAD meter to measure receiver SINAD ratio.

Figure 6 on page 56 shows the response of the C-message notched characteristic. Remember from part 1 that the C-message filter is used to attenuate frequencies that cause little or no detrimental effect to the system. Voice frequencies that contribute

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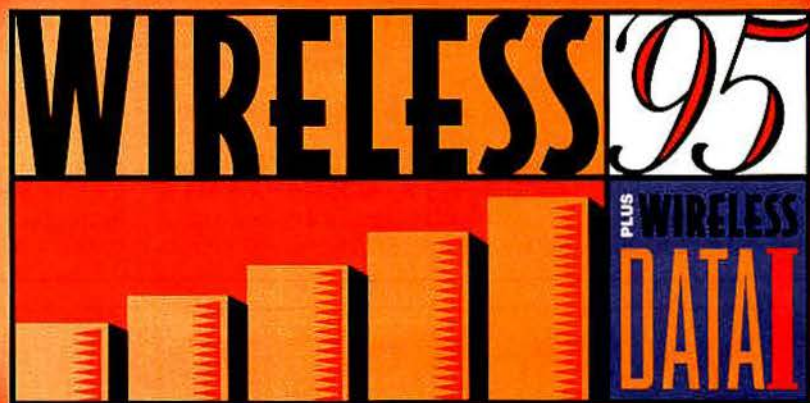
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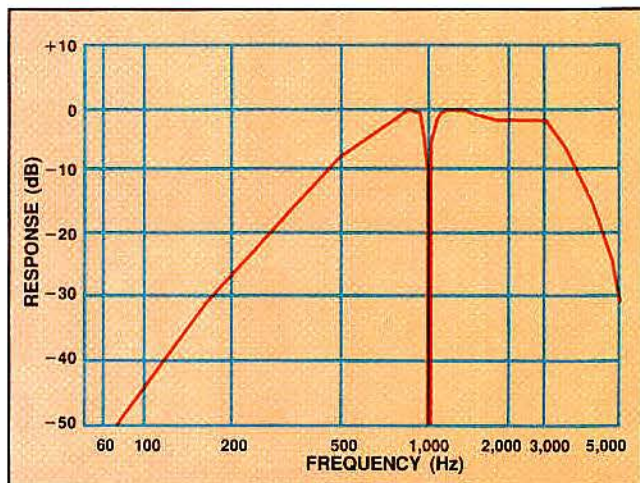


Figure 6. This is the response curve of the notched C-message filter. Note that the notch is at about 1,000Hz, and the signal level at this frequency is reduced about 50dB. This notch is used to reject the 1,000Hz component, and the remaining noise and distortion products then are measured and compared to the composite signal to determine the S/N ratio. *Courtesy Hewlett Packard.*

the most power in the speech signal pass with little attenuation. Note that the 1,004Hz tone is 50dB down. It is notched out by the filter to measure the remaining noise and distortion. It is important that the frequency of the tone used to check the

S/N ratio falls in the center of the notch to ensure accurate results.

To run the S/N ratio test on the line, an instrument such as the HP 4935A TMS or its equivalent is connected to one end of the line while a 1,000Hz tone (or 1,004Hz

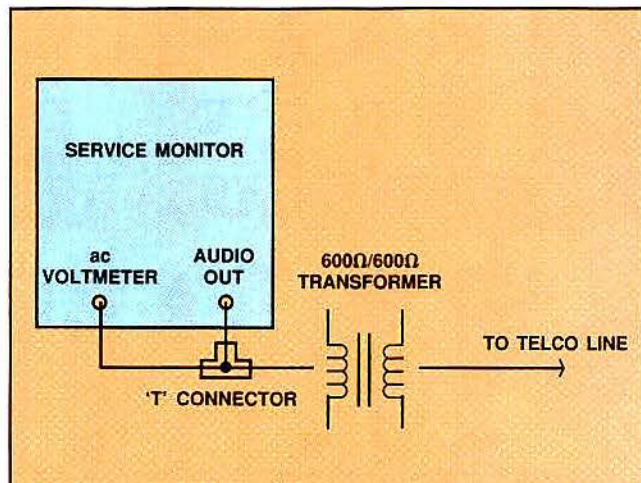
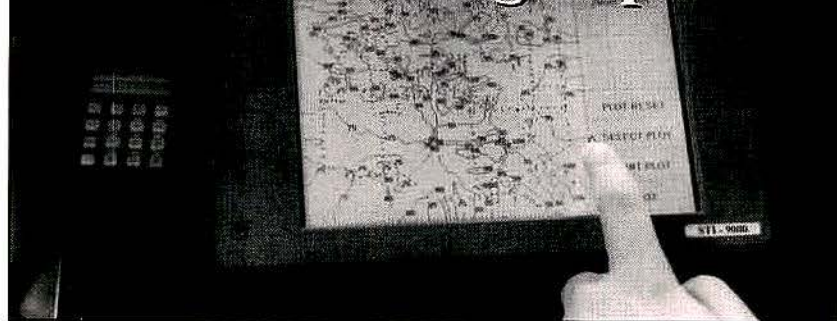


Figure 7. A typical service monitor can be used as shown here to feed an audio tone down the line through a line isolation transformer. The BNC "tee" connector is used to feed the tone into the ac voltmeter input so that the level can be set with the service monitor's internal voltmeter. Be sure to take into account any loss in the transformer to determine the input to the line proper.

tone, depending on the instrument used and the notch frequency) at 0dBm is injected at the other end of the line. (See Photos 2 and 3 on page 54.) Usually, the measuring instrument has a termination load resistor (600Ω) connected across the line on the

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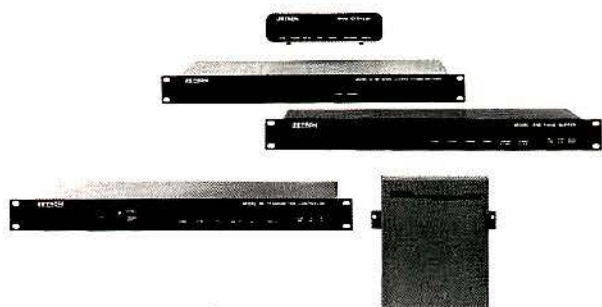
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## Technically speaking

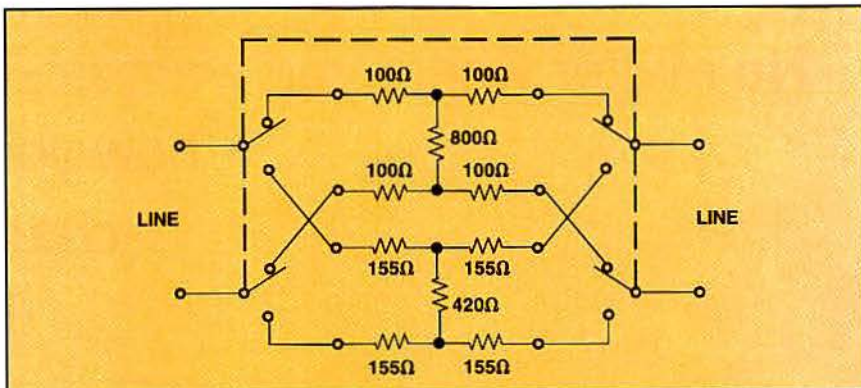


Figure 8. This represents two balanced H-pads that can be connected into the line to determine how much reserve is built into the tone-control system. One of the pads attenuates by 6dB, the other by 10dB. A four-pole, double-throw switch is used to switch between the 6dB and 10dB attenuation pads.

receiving or measuring end. If the system requires a 36dB S/N ratio for proper operation, the SINAD reading should be 36dB or greater.

### Other instrumentation

You might wonder why the SINAD meter used to measure SINAD receiver sensitivity cannot be used to measure line loss. The answer is: *Maybe it can be.* The problem is that with typical SINAD meters, the 1,000Hz reject notch is not deep enough or is not calibrated to a level low enough for measuring such a large SINAD ratio.

The Helper Instruments model CML-1 Sinadder, shown in Photo 4 below, comes close. It is calibrated down to 32dB SINAD. It actually can read finer than this, but it is uncalibrated below this level. The instrument will read downscale for SINAD levels much better than 32dB. The CML-1 also has the C-message filter, another plus for this type of work. Other advantages are its high sensitivity (10mV, or about -38dBm) and the built-in aural monitor that allows you to hear what you are measuring.

If you use this instrument, be aware of its limitations, and isolate the input through a 600Ω/600Ω transformer with a 600Ω termination. Also, it may produce

better results with battery operation to remove any ground reference.

Many service monitors can be used successfully for S/N tests on lines. Many service monitors have digital SINAD meters that can read to 45dB to 50dB SINAD. Some require higher tone input levels to operate. For example, one popular service monitor reads 45dB to 50dB SINAD, but it requires a signal input of at least 0.5V. This much signal usually is not available at the far end of a line with 0dBm (0.775mV) at the input side. A loss of 16dB would reduce the 0dBm signal at the sending end to 0.12V at the receiving end. This would be insufficient to operate such a SINAD meter.

You could use an audio amplifier to boost the signal to a level sufficient to operate the instrument, but the amplifier must have very low distortion and low noise. After all, the purpose is to measure the noise and distortion caused by the line, not the amplifier.

Always use a 600Ω/600Ω isolation transformer unless the instrument has a balanced input. Always make sure the line is properly terminated in a 600Ω termination on the measuring end.

Many service monitors also have synthesized audio generators with precise fre-



Photo 4. The CML-1 Sinadder is an example of a highly sensitive SINAD meter that can be adapted to measure line loss. Courtesy Helper Instruments.



quency control. These generators can be used to simulate various control tones. Be sure to follow usual precautions to avoid unbalancing the line. Figure 7 on page 56 shows how a typical service monitor with synthesized audio generator and a digital ac voltmeter can be used in line testing.

A switchable 6dB/10dB pad (600Ω in, 600Ω out) is shown in Figure 8 on page 58. This pad is a balanced H-pad. It can be inserted into the line to check the amount of reserve available. If the tone control system can operate properly with the 6dB pad in line, then there is enough reserve to overcome some increase in line loss without having the system go down. If the system operates well with the 10dB H-pad switched in, then so much the better.

### Conclusion

As you can see, there are more ways than one to skin a cat. Don't overlook possible uses of equipment that may be on hand. Just be sure that, when connecting equipment to telco lines, you do not unbalance the line, thus invalidating your measurements. Be sure to use the proper tone frequency when checking S/N ratio. Make sure that the tone frequency falls deep within the notch of the measuring instrument. First, feed the tone directly into the instrument, and vary the frequency until the best S/N or SINAD is indicated. This frequency may be 1,004Hz, 995Hz or any other value near 1,000Hz. If you can get a S/N reading of 45dB to 50dB, then you are set to go.

One final note. When dealing with carrier systems, be aware that frequency shift can occur. If the frequency shift is large enough, it may render tone-control systems inoperative. To be sure, feed a known frequency (about 1,000Hz) into one end of the line, and check the exact frequency at the opposite end. Sometimes even a small frequency shift can cause problems.

A couple of computer software programs that you may find useful when doing this type of work are available from the author. These are DBCALC and PADS. Among other calculations, DBCALC converts between dBm and rms voltage across 600Ω. The PADS program has been expanded to include balanced H-pad designs, T-pad designs, L-pad designs,  $\pi$ -pad designs,  $\pi$ -to-T (delta/gye) and T-to- $\pi$  (gye/delta) conversions. Both are available on a single diskette for \$10 plus \$2.50 for shipping and handling. These programs run on MS-DOS. Specify 3½" or 5¼" floppy diskette. You may write the author at 204 Tanglewyld Drive, Spartanburg, SC 29301-2949.

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## 'You are hereby ordered to pay, ah, something-or-other'

By Robert H. Schwaninger Jr.

The U.S. Court of Appeals has delivered a blow to the FCC's enforcement efforts by striking down the commission's Policy Statement, Standards for Assessing Forfeitures, 8 FCC Rcd 6215 (1993), which set out the level of fines for various transgressions. The court's decision in *United States Telephone Assn. v. FCC*, No. 92-1321 (D.C. Cir., July 12, 1994) has had a chilling effect on the FCC's enforcement efforts.

The reasons provided by the court for striking down the FCC's standard forfeitures are quite simple. As most of you know, the FCC creates rules through notice-and-comment rulemaking. In other words, the public must be provided the opportunity to make comments and sug-

Schwaninger, MRT's regulatory consultant, is a partner in the law firm of Brown and Schwaninger, Washington, DC. He is a member of the Radio Club of America.



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gestions regarding any proposed rule. The FCC did not employ this method in its creation of standards for assessing forfeitures. Instead, it attempted to create guidelines by edict.

The FCC argued, in essence, that its policy statement was not a "rule-rule," you know, with a capital "R." It was merely a statement of commission policy communicated to the public that was used by the agency's bureaus as a guideline.

The court responded with logic that sounded an awful lot like, "If it walks like a duck and quacks like a duck..." The upshot of the exchange was that the court ruled that the FCC had violated the Administrative Procedure Act in the creation of the policy statement and must, instead, engage in formal notice-and-comment rulemaking prior to reinstating its "policy."

The result of the court's ruling has been that the FCC's efforts to collect forfeitures has been thrown into chaos. Its files are filled with old Notices of Apparent Liability and such that require the wrongdoer to pay an amount that cannot now be supported by law. In addition, the commission is left with the unusual task of issuing notices that inform recipients they have violated the commission's rules, but that the agency will wait to decide how much to fine them.

At the time when the FCC issued the policy statement, the FCC tried to pass it off as an administrative action, like changing the location of a filing window or the filing deadline for future



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applications. But it is apparent that the policy statement became something much more than that. It became the basis upon which most fines were calculated for all purposes.

The reasons why the bureaus adhered to the policy statement are simple: First, there was no reason for a bureau to reinvent the forfeiture amount on a case-by-case basis with no obvious support from the commission. Second, the bureau demanding the forfeiture could claim that the policy statement was "legal" justification for any amount demanded. Third, the policy statement appeared to create an equal playing field among equal classes of violators.

Although the policy statement was well-intentioned, the execution of that same policy statement by the various bureaus often resulted in unequal treatment between violators. For example, one bureau might have sought a fine of \$8,000 for a particular violation by a private radio licensee, while another might have sought twice as much from a radio common carrier for the same violation.

One problem that should be dealt with by the FCC, upon reconsideration of its policy, is the issue of injury. The issue was not the basis of the FCC's earlier policy statement, and equity demands that it receive greater consideration in the future. For example, if the injury is to the FCC and its administrative processes, one level of forfeiture would be required. However, if the injury is to another carrier, another, higher level of forfeiture should be demanded. Finally, if the injury is to the safety of life or the welfare of the public, then an even higher amount should be due.

Not only would this analysis of its forfeiture procedures better serve the public interest, but it would track the average operator's sense of fairness and justice. It also would encourage greater cooperation among operators and promote service to the public. Finally, it would place the FCC in the position of treating violations of its rules the way the courts treat violations of civil law. This consistency would be better understood by the public. It would demonstrate that the FCC is more concerned with the public's safety and the peaceful operation of telecommunications facilities by its regulatees than it is about whether an operator assists in keeping the FCC's files in order.

Such an approach would enable the FCC to avoid questions of fairness that arise from its demanding a forfeiture of \$10,000 for intentional interference to a public safety radio facility, and then fining a radio common carrier \$30,000 for

failure to file a notification of construction in a timely manner. By any test or comparison, it is apparent that jeopardizing the public's safety by the creation of harmful interference is the greater offense, but the FCC has employed its policy statement to demand a greater amount for an alleged bookkeeping error.

In effect, the FCC's now-overturned policy statement set a higher fine for an "expired license plate" than it did for a

"hit-and-run accident," depending on who was operating the car at the time. If nothing else, the court's action allows the FCC an opportunity to review its well-intentioned, albeit questionable, forfeiture policy, and come up with a better view toward protecting the public interest rather than focusing on the assumed depth of the pockets of the perpetrators.



Receive only	Freq. Ranges (MHz)	N.F. (dB)	Gain (dB)	Comp. (dBm)	1 dB	Device Type	Price
P30VD, P35VD, P40VD, P45VD	30-35, 35-40, 40-45, 45-50	<1.3	15	0		DGFET	\$ 44.95
P30VDG, P35VDG, P40VDG, P45VDG	30-35, 35-40, 40-45, 45-50	<0.5	26	+12		GaAsFET	\$109.95
P150VD, P160VD, P170VD	150-160, 160-170, 170-180	<1.5	15	0		DGFET	\$ 44.95
P150VDA, P160VDA, P170VDA	150-160, 160-170, 170-180	<1.1	15	0		DGFET	\$ 56.95
P150VDG, P160VDG, P170VDG	150-160, 160-170, 170-180	<0.5	24	+12		GaAsFET	\$109.95
P450VD, P460VD	450-460, 460-470	<1.8	15	-20		Bipolar	\$ 49.95
P450VDA, P460VDA	450-460, 460-470	<1.2	16	-20		Bipolar	\$ 74.95
P450VDG, P460VDG	450-460, 460-470	<0.5	16	+12		GaAsFET	\$109.95
P800VDG, P830VDG, P860VDG	800-830, 830-860, 860-890	<0.6	19	+12		GaAsFET	\$119.95
<b>Inline (rf switched)</b>							
SP30VD, SP35VD, SP40VD, SP45VD	30-35, 35-40, 40-45, 45-50	<1.4	15	0		DGFET	\$ 74.95
SP30VDG, SP35VDG, SP40VDG, SP45VDG	30-35, 35-40, 40-45, 45-50	<0.55	26	+12		GaAsFET	\$139.95
SP150VD, SP160VD, SP170VD	150-160, 160-170, 170-180	<1.6	15	0		DGFET	\$ 74.95
SP150VDA, SP160VDA, SP170VDA	150-160, 160-170, 170-180	<1.2	15	0		DGFET	\$ 86.95
SP150VDG, SP160VDG, SP170VDG	150-160, 160-170, 170-180	<0.55	24	+12		GaAsFET	\$139.95
SP450VD, SP460VD	450-460, 460-470	<1.9	15	-20		Bipolar	\$ 79.95
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## Dataradio to supply radio modems, datalink equipment for NCIC 2000

Dataradio, Atlanta, has been selected to provide its Vehicular Information Solutions (VIS) products, including radio modems and datalink equipment, for NCIC 2000, the multi-year modernization program for the National Crime Information Center (NCIC), Washington, DC. Funded by the Department of Justice (DOJ), the multi-million-dollar project will upgrade the 27-year-old NCIC operated by the Federal Bureau of Investigation, Washington, DC.

The Turbo mobile radio modems (Turbo-MRM) and base-station datalink controllers (BDLC) were selected as the

NCIC 2000 patrol car segment government-furnished radio interface for NCIC 2000. The modems are compatible with DOJ government-furnished equipment (GFE) radios, which are an FBI version of Motorola Spectra mobiles and Motorola MSF 5000 base stations.

Installation of the equipment will begin later this year as part of the pilot phase. It is expected that 12,000 DOJ vehicles will be equipped with the Turbo-MRMs to provide mobile computing capabilities to Justice field personnel. Installation will begin in 1995 and will be completed in 1998.

## HTE acquires selected assets of pen-based computer company

Local-government software company, HTE, Winter Park, FL, has acquired selected assets of McEvoy Mobile Computer Systems, Hartford, CT. McEvoy specializes in pen-based computer software for public safety agencies such as police, fire and emergency medical.

## Simmonds selects SEA 220MHz land mobile equipment

Simmonds Communications (SCL), Toronto, Ontario, Canada, has placed a \$1.4 million order with SEA, Mountlake Terrace, WA, for additional 220MHz repeater and mobile radio products. This order of 275 channels is to be delivered over five months and complements a previous Simmonds order of 30 channels.

## Spacecom to provide satellite services for Mtel's Destineer subsidiary

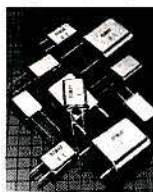
SpaceCom Systems, Tulsa, OK, a subsidiary of the United Video Satellite Group, has been selected to provide satellite network services and equipment for Destineer, a subsidiary of Mobile Telecommunication Technologies (Mtel), Jackson, MS. Destineer, which was awarded one of the nation's first PCS licenses by the FCC on July 13, will use SpaceCom's satellite transmission and software capabilities to implement its new two-way nationwide wireless network.

## Peninsula Engineering changes name

Peninsula Engineering, Sunnyvale, CA, has changed its name to Peninsula Wireless Communications to better define the nature of the company. After 10 years of being asked for solutions to specific microwave and cellular applications as an engineering company, Peninsula continues to take on a greater role as a supplier to both markets as a manufacturer of "off-the-shelf products" in the wireless communications industry.



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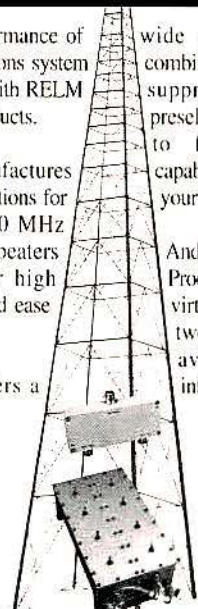
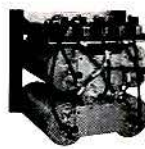
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## Readers' choice

Of all the new products and services in the April 1994 issue, the ones reprinted here generated the most reader requests for additional information. If you missed them the first time, here is your opportunity to acquire more information on them. Just circle the corresponding Fast Fact Card number on the card found in the back of this issue and mail the card to us.

### Low voltage disconnects monitor battery using user-adjustable levels

The LVD 12-30 and LVD 24-20 low voltage disconnects from **Newmar** prevent over-discharge of backup batteries when ac power is lost for an extended time. The units are wall-mountable and installed in-line with the power leads between the battery and the load. The monitor-and-control circuit checks backup battery voltage and disconnects the load when voltage falls below a preset cutoff point. The load is automatically reconnected when the batteries are recharged. Levels are user-adjustable to accommodate different batteries and load conditions. The LVD12-30 is for 12V systems ranging to 30A, and the LVD 24-20 is for 24V systems ranging to 20A.



Circle (500) on Fast Fact Card

### Upgraded numeric pager features enhanced design and functions



**Motorola** introduces an upgraded replacement for its Bravo pager. The Bravo Classic is a numeric pager that enables users to read callers' phone numbers from a 12-character, top-mounted LCD. Callers can include additional information such as phone extensions and ID numbers by leaving messages longer than 12 characters. These messages get continued onto easily accessible "additional" screens. The Bravo Classic stores as many as four messages into protected memory. Other features include backlit display, time-stamping of messages, audible or vibration alert, reminder alert and low-battery alert. The 3.1-ounce unit operates on one AA battery and measures 2.87"L x 1.95"H x 0.75"D.

Circle (501) on Fast Fact Card

### 'Shirt pocket' FM transceiver offers features, power of larger portables

The **MicroTalk** FM transceiver from **Advanced Videotech** shrinks two-way technology into a



4" x 2" x 1 1/2" "shirt pocket" unit with the power and features of larger portables. The transceiver has 10 synthesized channels and 1W-5W selected output in the VHF and UHF bands. The channel number LCD is illuminated for use in low-light conditions, and the push-button channel scan operates automatically to help locate specific users. Other features include busy channel lock-out, TX/RX signal strength indicator, battery-saving circuitry, low battery indicator and wide bandwidth frequency capability.

Circle (450) on Fast Fact Card

### Communications platform presents variety of mail, messaging features

**Velocity**, a wireless communications platform from **Hark Systems**, encompasses voice mail, alpha transcription, alpha entry, TNPP routing and auto attendant features. Encoding and fax services will be added to the platform. Hark has a license from Motorola's Paging Products Group to incorporate the Flex protocol in the Velocity platform, as well as in Hark's Verifier multi-format paging decoder.

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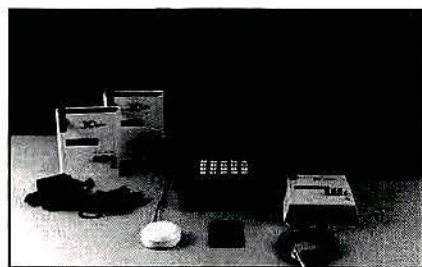
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## New products

RF propagation study kit includes signal meter, stick-up transmitters



A complete RF propagation study equipment kit is available from **Berkeley Varitronics Systems**. The kit includes the Champ hand-held signal strength meter (equipped with a removable PCMCIA memory card and internal GPS), three Spyder battery-powered stick-up transmitters, software, microphones, cables, batteries, antennas, headphones, charging transformers and case. The kit allows users to place the transmitters throughout a building or other area under study. Data can be collected by simply "walking-about" using the receiver/meter. Data is stored on the PCMCIA card and can be post-processed on a PC. For vehicular measurements, the internal GPS navigation system records latitude and longitude along with signal strength levels as the test vehicle drives through the coverage area. This aids in mapping coverage overlap and finding system strengths and weaknesses.

Circle (452) on Fast Fact Card

Small footprint glass-mount antenna presents sleeker, smaller appearance

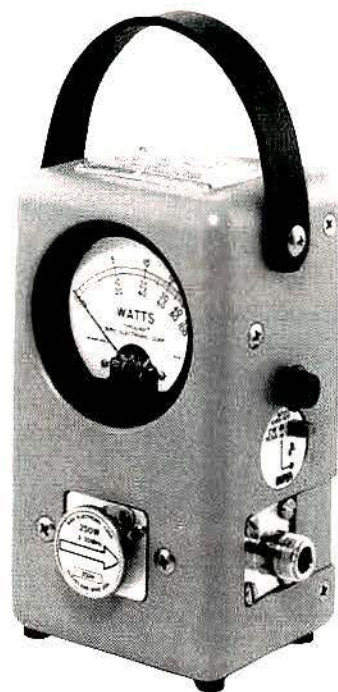
The downsized KGK 825/900 window clip, glass-mount antenna from **Larsen Electronics** is designed for use with hand-held portable and transportable phones and radios. The KGK 825/900 is redesigned to be 30% smaller than its predecessor for a tighter fit, and it features a circuit board design. A thin, stainless-steel clip is used to provide a tight grip against the window, and the housing has been changed to durable Makroblend for a sleeker design. The small footprint antenna is available with unity, 3dBd open, 3dBd enclosed and 5dBd enclosed whips.

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## Hand-held antenna analysis unit plots SWR vs. frequency on LCD

The 150-400 Antenna Analyst (150MHz-400MHz continuous) provides comprehensive antenna performance information in an easy-to-read graphic format for commercial, governmental and military applications. The hand-held analyst from **Advanced Electronic Applications** displays an antenna's SWR vs. frequency plots on an LCD screen over a SWR range of 1:1 to 10:1. The LCD read-out displays the SWR curve over the entire frequency range, as well as at single frequencies. The analyst also measures return loss in dB. A keypad allows users to select the center frequency, the frequency

range and the step size. A serial interface allows computer control, and optional software allows users to store SWR plots in a PC for later reference, comparison or printing. The lightweight (26 ounces) analyst operates on battery power or can be powered by an external 12Vdc-16Vdc source.



Circle (454) on Fast Fact Card

## Trunked mobile radio uses digital narrowband linear modulation

The Viking LR trunked mobile is **E.F. Johnson's** first radio using digital narrowband linear modulation (LM) technology in the 220MHz band. The radio also has a 9,600bps data capability. The radio's linear digital trunking features include wide-area networking and telephone interconnect operation, with 99 programmable system and group combinations. The Viking LR also has a backlit

LCD, ramp controls for on/off/volume, variable memory configuration, unique identification (UID) for private unit-to-unit trunked calls, and message queuing for missed calls. Linear modulation uses 5kHz channels instead of 25kHz channels and provides users with access to five channels in the same bandwidth as a typical 800MHz or UHF channel.

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## New products

### Data-ready mobile offers 800MHz conventional, trunking operations



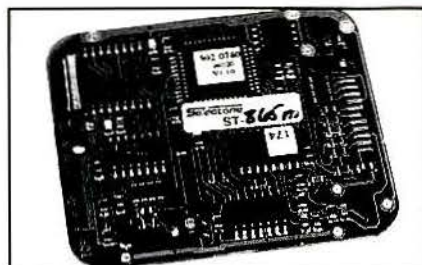
Standard Communications' GX5810T is a compact, data-ready, 15W mobile with all the features necessary for dual-protocol trunking. The mobile is compat-

ible with E.F. Johnson LTR and Motorola Privacy Plus trunking formats. It also operates as a conventional 10-channel, 800MHz radio, supporting talkaround channels. The radio's programmable scan function allows the user to monitor channels preprogrammed in the radio. The radio can be programmed for both CTCSS and DCS tones using a PC. Telephone interconnect is possible through an optional DTMF mic. Other features include password protection for programming software, vehicle horn/lights alert for incoming calls, and status indicators for TX, busy and call verify.

Circle (456) on Fast Fact Card

### Logic board incorporates portable units into digital signaling format

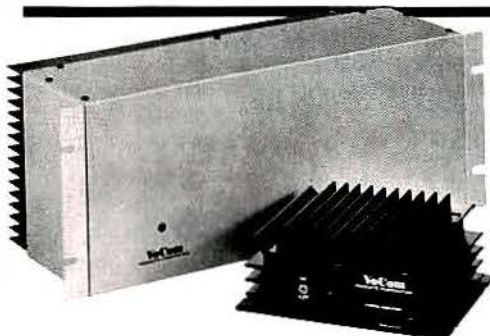
The ST-865M SmarTrunk II mobile logic board from Selectone is designed for Motorola GP300 and GP88 portable transceivers. The SmarTrunk II proprietary digital signaling format provides a choice of operating modes including radiotelephone trunking, fleet dispatch trunking and conventional operation. "Cellular-like" features for the end-user include store and send dialing, automatic 10-number memory speedial, last number redial and faster channel access time. For the system operator, SmarTrunk II provides choice of operating modes, protection against unauthorized use, security password for dealer programming and



remote disable of non-paying users. SmarTrunk II is both upwardly and downwardly compatible with Selectone's original SmarTrunk signaling format.

Circle (457) on Fast Fact Card

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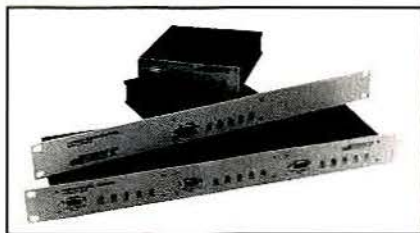
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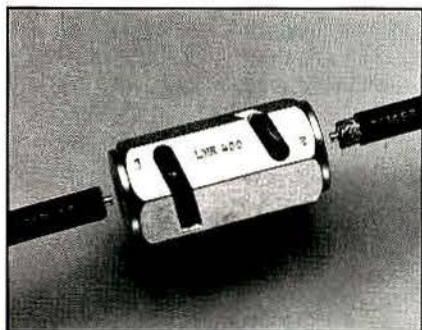
## Repeater tone panel supports 157 subscribers in CTCSS, DCS formats

The model TP-3200 shared repeater tone panel from **Communications Specialists** is a complete tone and control interface between the repeater receiver and the transmitter. The panel supports 157 repeater subscribers in CTCSS and DCS signaling formats. Full-featured, simple, menu-driven RS-232 programming is accomplished locally by computer or remotely with a modem over landline. DTMF programming on the repeater channel is also included. The TP-3200 is avail-



able in desktop or rack-mount versions.  
Circle (458) on Fast Fact Card

## Prep tools strip coaxial cable for attachment of clamp-style connectors



Cable prep tools for the LMR-400, LMR-500 and LMR-600 series cables are now available from **Times Microwave**. In a simple, two-step process, the tools strip the cable end for clamp-style connector attachment, allowing for high-quality assemblies to be fabricated in the field. The LMR cables are low-loss, polyethylene foam dielectric cables. Connector types available include N, TMC, SMA, BNC, UHF and  $7/16$  DIN.

Circle (459) on Fast Fact Card

## CHECKMATE IV FIRE PAGER



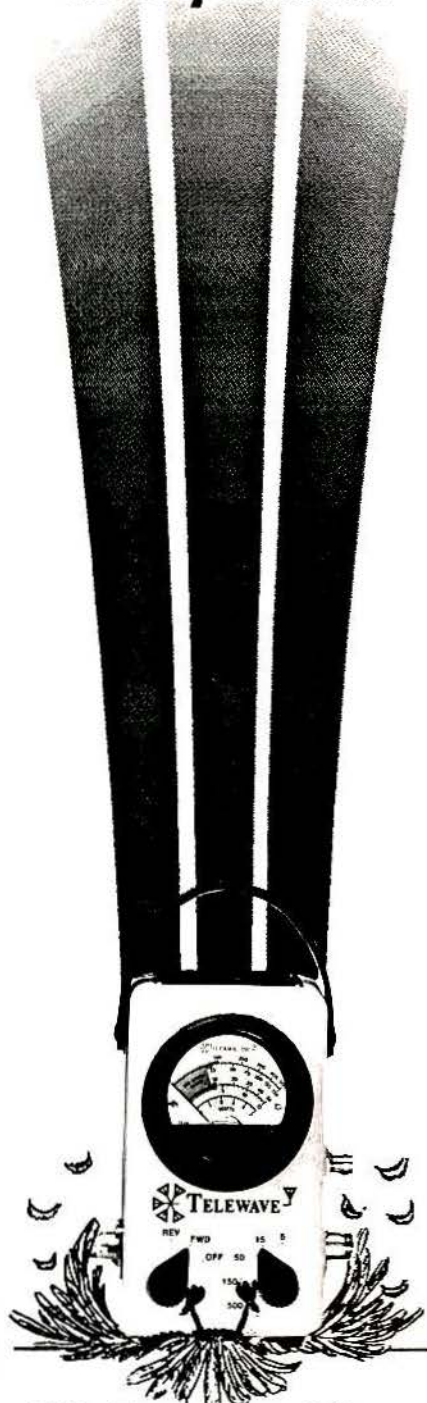
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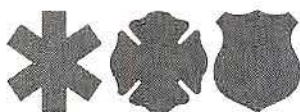
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## New products

Finger-friendly scanning portable  
offers format, frequency choices

The M-RK Scan portable radio from **Ericsson GE Mobile Communications** is available in conventional or EDACS formats. The radio features a six-button keypad with large, finger-size buttons for easier handling. The keypad includes an up-and-down button to toggle through user groups or channels. A special menu key selects additional features. A scan button turns scan operations on or off. An add/delete button allows users to select groups or channels from the scan list. The PC-programmable M-RK Scan has a two-line alphanumeric display to indicate operating information such as system, group, caller ID and status. A 16-position control knob allows access between channels or trunked groups. The 20-ounce radio, 7" high, is available in VHF, UHF, 800MHz and 900MHz models.



Circle (460) on Fast Fact Card

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Circle (70) on Fast Fact Card



## Enhancements add two-tone paging capabilities to simplex repeater



The enhanced Model 19 Simplex from Zetron has an expanded audio bandwidth that enables it to support two-tone paging applications with tone frequencies ranging from 300Hz to 2,000Hz. This allows the unit to be used to fill in the coverage gaps or to extend the range of two-tone paging systems as well as conventional radio voice commu-

nications. The Simplex is an automatic, store-and-forward playback recorder that commonly functions as a simplex repeater. When connected to a base station or mobile radio, the unit records the voice broadcasts or two-tone pages from a radio channel and retransmits them as soon as the channel is clear. Because a simplex repeater uses the same frequency for both recording and rebroadcasting, it requires no special licensing. Model 19 uses a digital storage medium that provides immediate replay, with no pauses for rewind time. An external DTMF decoder can be added to create an "automatic radio tester" that repeats any transmission on a demand-only basis.

Circle (461) on Fast Fact Card

## VHF antenna widens frequency availability to 215MHz-300MHz

Centurion International has designed a VHF broadband antenna to cover 215MHz-300MHz, eliminating the need for several antennas to cover the same frequency. The high-performance, durable antenna will be available with a BNC and TNC connector. The antenna gives the user a wider frequency band than is currently available.

Circle (464) on Fast Fact Card



## Bandpass-bandreject duplexers provide 275kHz frequency spacing

Two models of bandpass-bandreject duplexers for 30MHz-50MHz operation with 275kHz minimum frequency spacing are now available from Telewave. The duplexers are specifically designed for frequency-congested areas requiring maximum transmitter sideband filtering. Model TPRD-0304 has a tuning range of 30MHz-39MHz. Model TPRD-0404 has a tuning range of 40MHz-50MHz. Both models have two pass/reject cavities in the transmitter and in the receiver with 350W maximum input power. Insertion loss less than 0.5dB to 2dB or more with corresponding increases in selectivity can be achieved.

Circle (462) on Fast Fact Card

## Shunt-type power mains protectors handle direct lightning hit energy

PolyPhaser's Shunt-type Power Mains (PM) Protectors are designed for building entrances where direct lightning strike energy can be present. The MET- (NRTL) approved protectors are rated for 40kA, 8/20 surges for phases, and have both local and remote status indicators. Available in single, bi-phase and tri-phase configurations with voltages from 120Vac to 480Vac, these easy-to-install protectors have all-metal enclosures with mounting tab and nipple. Surge energy is shunted to ground and not to the neutral line where it can reach other equipment. Neutral protection is included together with hot phase(s) protection. The protectors have a fast (<25ns) full lead length response time, a wide temperature range (-40°C to 71°C) and carry a 10-year warranty.

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Circle (72) on Fast Fact Card



## Catalog features antennas, accessories

A 44-page color catalog describes **Antenna World's** main antennas. The AM/FM section covers basic, electronic and motorized antennas, as well as cables, adapters and mounting. A separate info sheet on Mercedes antenna solutions is included. In the cellular/communications section of the catalog are mobile, base and portable antennas for two-way, cellular and amateur radio. Whips, mounts, cables and connectors are presented in an easy-to-use format.

Circle (300) on Fast Fact Card

## Newsletter covers network performance, services

*Telecommunications News* is **Hewlett-Packard's** quarterly publication for operators of public telecommunications networks. The newsletter contains information on HP solutions, products, literature and training. Article topics include network management, fiber optics, WAN/LAN, wireless and broadband/ATM.

Circle (301) on Fast Fact Card

## Catalog lists electronic controls

A 32-page catalog features **SSAC's** most popular in-stock controls: time delay relays, encapsulated timing modules, universal timers, alternating relays, three-phase voltage monitors, current sensors, liquid level controls, flashers and accessories. An index and a product selection guide streamline product choice, and each page contains all of the specifications needed to select one of the stock part numbers shown on that page.

Circle (302) on Fast Fact Card

## Catalog highlights test instruments

A 48-page supplement catalog from **Contact East** describes test instruments and tools for engineers, managers, technicians and hobbyists. Products include DMMs and accessories, soldering tools, custom tool kits, EPROM programmers, power supplies, ELF meters, books, breadboards, scope meters, datacom tools and testers, adhesives, measuring tools, precision hand tools and portable and bench top digital storage scopes.

Circle (303) on Fast Fact Card

## Catalog includes cellular phone accessories

A 52-page catalog from **Ora Electronics** provides detailed information on cellular and home office/computer support and enhancement products. The book is divided into three sections: cellular phone accessories; computer/home office accessories; and general cellular, computer, mobile and audio/video accessories. Included is an accessory guide in a table format for virtually all portable cellular telephones.

Circle (304) on Fast Fact Card

## UPS selector available in slide chart format

A two-color pocket UPS Selector slide chart from **Tripp Lite** has easy-to-follow instructions that guide the user through the sometimes complicated task of UPS selection. To use the slide chart, the user simply lines up the arrow at the predetermined power and backup time requirements of the equipment to be protected. The correct Tripp Lite UPS models that coincide with the users' parameters appear in the boxes at the bottom of the chart.

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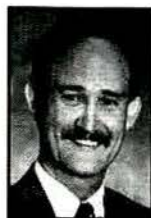
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Blosser



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**Robert Harvey** exits Repcan Communications, Sandford, Ontario, Canada, as president to join Larsen Electronics, Vancouver, WA, as OEM sales manager.

**Steve Blosser**, vice president of business development for Ericsson GE, Lynchburg, VA, retires after more than 35 years of service with the company.

**Carl B. Frampton**, chief financial officer and vice president at Microwave Networks, Houston, advances to executive vice president.

**Dean A. Gilbert** departs KBLCOM, Houston, as executive vice president of group operations to join Positive Communications, Pleasanton, CA, as president.

**Ellen C. Wolf** leaves Bell Atlantic, Philadelphia, as executive director-strategic planning and business development to join its subsidiary, Bell Atlantic Mobile, Bedminster, NJ, as vice president of finance and planning.

**Geoffrey M. Knoerzer** departs the Chicago office of Cincinnati Bell Information Systems (CBIS) as development director to become vice president of operations for Subscriber Computing, Laguna Hills, CA.

**E. Kirk Ellis** exits Carolina Power & Light's wireless technologies design unit, Raleigh, NC, as a radio engineer to join Lawrence Behr Associates, Greenville, NC, as director of project integration.

Changes at Modular Communications (Moducom), North Hollywood, CA:

**Robert Vincent** leaves E.F. Johnson, Burnsville, MN, as district manager to join Moducom to head the company's eastern region in Atlanta.

**Ronald McLaughlin** departs Oki Telecom, Suwanee, GA, as major account manager for carrier sales to head Moducom's western region in Oakland, CA.

Promotions at Nextel Communications, Rutherford, NJ:

**James M. Dixon**, president of digital mobile operations, takes on additional responsibility as executive vice president.

**Jack Markell**, vice president of strategic planning, moves up to senior vice president for corporate development.

**Elizabeth G. Long**, treasurer, advances to vice president and treasurer.

**John Pescatore**, director of operations, moves up to vice president of operations.

**Allen Salmasi**, senior vice president and general manager of the wireless telecommunications division for Qualcomm, San Diego, advances to president of the wireless telecommunications division.



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# L

## etters from readers

I am writing in response to your editorial titled "Technician licensing might lead to proper transmitter licensing" in the May 1994 issue.

It is my belief that licensing of technicians would not help to reduce the amount of non-licensed and clandestine radio transmitters. By my observations, most of the non-licensed radios are present due to the fact that the sale of the radio was by a salesperson with little or no technical background, and even less understanding of the FCC rules.

This is especially true with the larger firms that have separate sales and service departments/centers.

Maybe the answer is to start requiring some type of licensing of salespersons before selling radios!

I have seen in my area several cases where radios were sold to businesses and were put on the General Mobile Radio Service (GMRS) band. When we contacted the seller, he had no idea that there even was a GMRS or that businesses were not allowed to be on these frequencies!

Kurt Fritsch  
Owner

DAT2 Communications  
Pasadena, MD

### Fast Fact Card comments:

The toughest problem facing me on the job is the FCC delay in processing frequency requests.

Gary Granneman

California Poly State Univ.  
San Luis Obispo, CA

The two toughest problems facing me on the job are:

- Educating users.
- Collecting from deadbeats.

John Ryan

Ray Stone Inc.  
Sacramento, CA

The toughest problems facing me on the job are:

- Servicing SMTs.
- Shortage of new technicians.
- Getting service manuals.

William Green

Ziff Communications  
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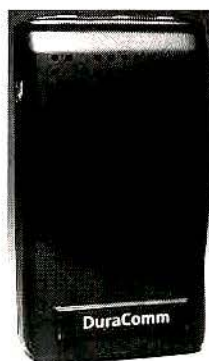
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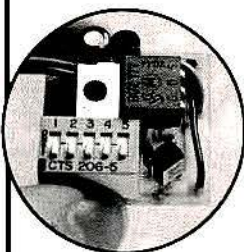




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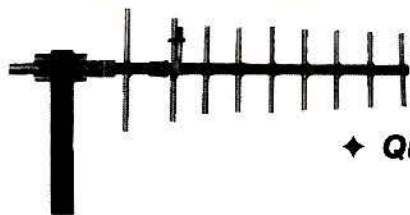
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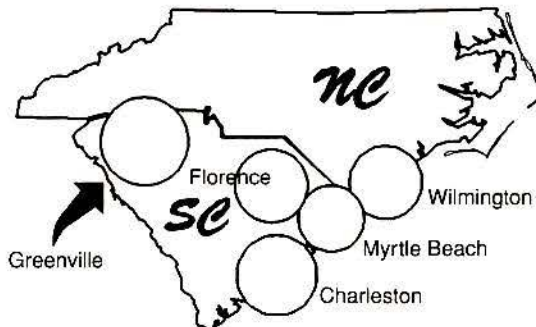
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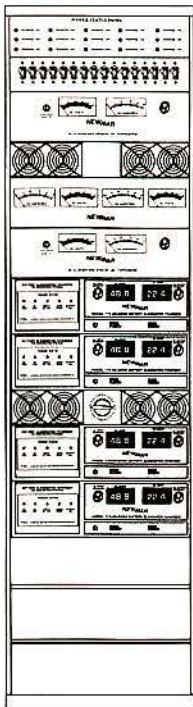
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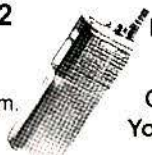
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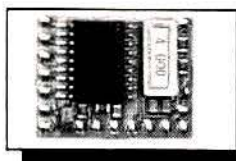
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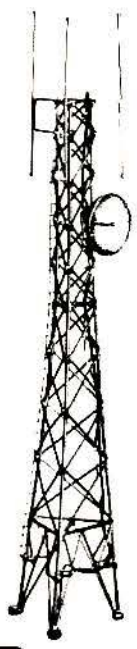
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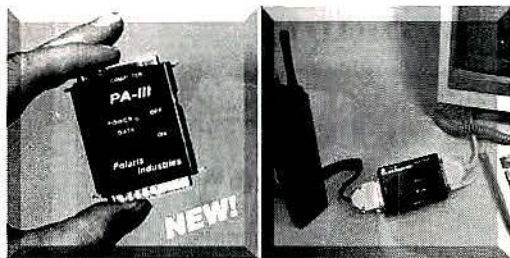
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- 4 ea. MX350, 155 MHz, H43AAU3140
- 2 ea. Micor Bases, 47 MHz, C71RTB3105
- 63 ea. Mitrek, 47 MHz, T81JJA4000
- 8 ea. Mitrek, 48 MHz, T51JJA4900
- 25 ea. Micor, 47 MHz, T71RTN3100
- 5 ea. MT500, 47 MHz, H31BBU3100
- 2 ea. GE Custom MVP, 47 MHz, CT54AAU33A
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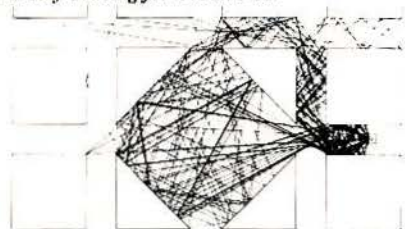
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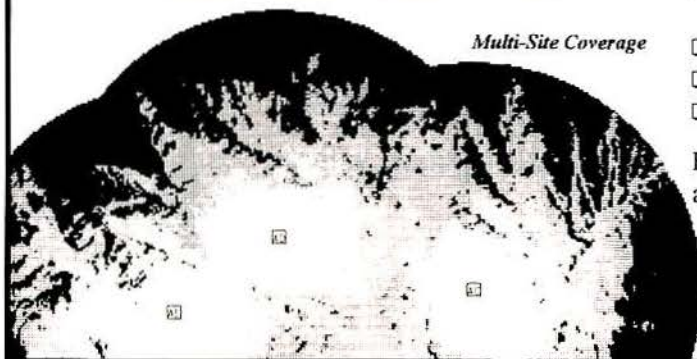
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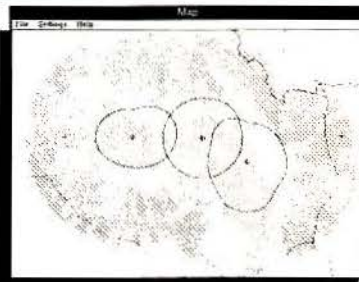
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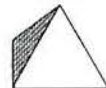
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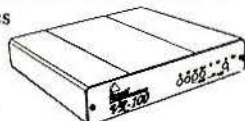
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